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CATV

CABLE CONSTRUCTION MANUAL

J. LUKOMSKI

3RD EDITION

CATV CABLE CONSTRUCTION MANUAL

Comm/Scope, Inc.
THE Cable in Cable TV.

Published Dec. 1980

CATV CABLE CONSTRUCTION MANUAL

The information and procedures presented in this manual are intended to be a helpful guide for the handling and installation of coaxial cable for CATV Systems. It is not intended to be applicable or suited to every circumstance which might arise during construction phases of CATV Systems. No warranty is implied nor expressed and this manual should not be construed to be a replacement for sound judgment and experience as applied to actual field circumstances.

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Comm/Scope, Inc.
THE Cable in Cable TV.

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Frank M. Drendel
Chairman of the Board

All of us here at Comm/Scope hope that the information provided in the following pages will in some way make your job a little easier.

You see, as the world's leading manufacturer of coaxial cable, our goal is more than just providing you with the finest coaxial cable available.

Proper construction techniques combined with Comm/Scope cable products is enabling our industry to build state of the art CATV systems that are fast becoming a major influence in both home and business communications in the 1980's.

Together we are building a better America.

Respectfully,

Frank M. Drendel

Frank Drendel
Chairman of the Board

CATV CABLE CONSTRUCTION MANUAL

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Cable Handling

CABLE HANDLING
CABLE PACKAGING, LOADING AND UNLOADING

CABLE PACKAGING

At the factory, after the cable has been completed and spooled onto appropriate reels with the cable ends properly sealed, the exposed cable on the reel is covered with a cardboard cover as shown in Figure 1. The cardboard cover starts and ends at the location on the reel where the top end of the cable is located. The bottom end of the cable is located under a metal cover plate stapled to one side of the reel flange near the center of the reel. The completed reel package is shown in Figure 2.

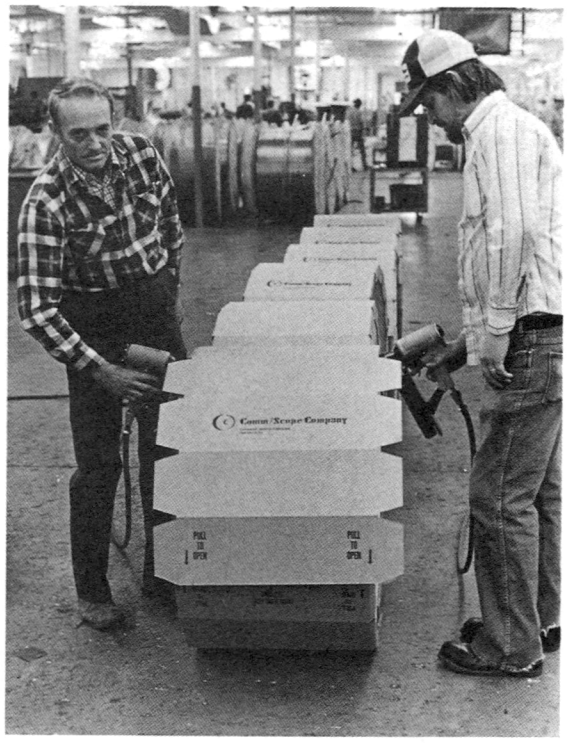


FIGURE 1

CABLE LOADING

After the reel package is completed, the reels are stacked on their sides on supporting timbers for access by lift truck equipment. See Figure 3. These stacks of cable reels are then loaded onto shipping vehicles to be transported to the user's location.

FIGURE 2

CABLE HANDLING

To assure timely delivery and cable reel handling without freight damage, Comm/Scope Company loads many shipments of cable onto their own fleet of vehicles. These vehicles are equipped with special cable reel handling equipment. At the delivery site, the cable reels are unstacked out of the vehicle and lowered to the ground or warehouse floor using the special reel handling winch equipment. The cable reels are then rolled to the proper inside or outside storage areas.

FIGURE 3

FIGURE 4

CABLE UNLOADING

If the cable is not delivered by a Comm/Scope truck , the following unloading techniques should be used:

1. Where loading docks and lift truck facilities are available, the cable reels may be unloaded in the same manner in which they were loaded.

2. Where loading docks are available and no lift truck equipment exists, each reel should be carefully lowered from the stack to the floor of the truck and then rolled off the truck onto the dock and subsequently to adequate inside or outside storage areas. Care should be taken not to drop reels from the stack to the truck floor, since severe cable damage can result.

3. Where no loading dock is available, adequate personnel should be on hand for properly unloading the cable to the ground. If lift truck facilities are available, all reels immediately on the back of the truck can be unloaded and lowered with the lift truck. The remaining cable reels should then be unstacked inside the truck and moved to the rear for access by the lift truck. The same unstacking techniques should be utilized as described above. The lift truck should transport the cable to the proper inside or outside storage area.

4. Where no unloading dock or lift truck is available, the same unstacking techniques as previously described should be utilized inside the truck. Reel unloading rails with adequate devices to fasten them to the back of the truck should be available to properly unload the reels without damage, per Figures 5 and 6. Unloading rails can be readily fabricated from 2 x 12 timbers available from any lumber supplier. Adequate personnel should be available to guide and restrain the reel down the rail to the ground.

For unloading larger and heavier reels, a pipe may be placed through the reel with ropes attached to the pipe on each side of the reel so that personnel in the truck can assist personnel on the ground in guiding and controlling the cable reel as it is lowered down the unloading rails.

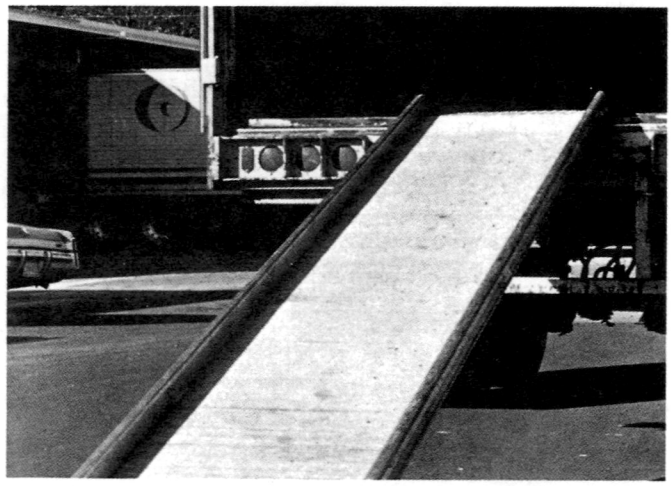


FIGURE 5

FIGURE 6

When each cable reel has been lowered to the ground, and the pipe and rope removed, where utilized, the cable reels are then rolled to the proper inside or outside storage areas. Care should be taken never to drop reels of cable from a truck floor to the ground, since severe cable damage can result.

In all cases, when rolling cable on the ground, care should be taken to avoid rocks or other debris which will puncture the protective wrap and damage the cable.

CABLE STORAGE

When the cable is positioned in the storage area, the reels may be stacked on their sides with the bottom reel placed on a pallet or supporting timber so that moisture will not accumulate, thereby damaging the reel packaging. The cable may also be rolled together end to end. See Figure 7.

Caution should be used when storing cable utilizing this method so that the edges of the reels do not damage the cardboard wrapping on adjacent reels, but rather rests against the other reel edges.

FIGURE 7

When storing cable in outside areas, support timbers should be placed under the reels for proper protection of the reel package. All reel packages should be covered with a protective cover suitable for protecting the reel packages from deterioration by the elements.

CABLE RECEIVING

PROPER RECEIPT OF CABLE REELS FROM THE DELIVERING CARRIER

Proper receipt of cable reels from the delivering carrier is of the utmost importance. The consignee should perform a quick visual inspection of each reel as it is unloaded from the truck. All reels with apparent damage or suspected damage should be rolled aside.

Notations such as ''1 reel damage'', or 1 reel damaged, 1 possibly damaged; subject to inspection'', or similar notations should be made on the delivery receipts. The truck driver should then sign the carrier's copy of the delivery receipt as well as the consignee's copy of the delivery receipt.

Any concealed damage after the cable has been received, must be brought to the attention of the carrier within 15 days from the date of delivery. Should this be the case, the consignee should call the carrier and specifically request a concealed damage inspection, and this request should be followed up in writing if the carrier does not respond within 24 hours. This then becomes the consignee's basis for a freight damage claim against the carrier.

For further information concerning freight damage merchandise, refer to a freight claim rule book usually available from the freight carriers.

Cable Unpackaging and Test Procedure

CABLE UNPACKAGING AND TEST PROCEDURE

Cable selected for testing should be partially unpacked and prepared as follows:

CABLE UNPACKAGING

1. When the cable is packaged at the factory, the end of the cardboard reel cover is situated so that when it is removed, approximately 2 feet around the reel, the outside cable end of the reel is exposed. The inside cable reel end is accessible by removing the cover fastened to the reel flange located on one side of the reel near the reel center. At the factory, both ends of the cable are protected by cable caps. See Figure 1. Remove the cable caps and prepare the cable ends for proper test connectors.

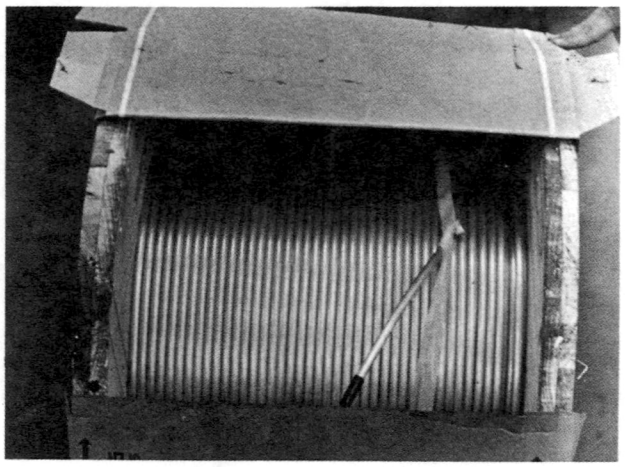


FIGURE 1

2. The cable testing and block diagrams which follow should be utilized for properly testing the impedance uniformity (SRL) and attenuation characteristics. After the testing of a reel is completed, cut the center conductor back to the dielectric and replace the caps on each end of the reel and replace the cardboard reel cover.

COAXIAL CABLE IMPEDANCE UNIFORMITY/STRUCTURAL RETURN LOSS (VARIABLE RF BRIDGE METHOD)

I. SCOPE

This procedure describes a method of determining coaxial cable impedance uniformity by means of structural return loss (SRL) versus frequency measurements. A variable RF bridge and sweep-frequency techniques are employed.

The test circuit sensitivity should allow structural return loss measurements of at least 40 db, from 5-300 MHz, to be made on a nominal 75-ohm impedance cable.

II. PREPARATION OF TEST SPECIMENS

Cable of such lengths as specified by order or specification shall be prepared by fitting cable ends with either standard connectors or proper impedance characteristics or with appropriate type N-75 (Modified) slip fittings.

III. METHOD

A. Equipment

1. Sweep Generator - Wavetek 1801 or equivalent.
2. RF Switch
3. RF Amplifier) Wide Band Engineering A51 Analyzer or equivalent.
4. Detector)
5. Variable RF Bridge - Wide Band Engineering A56 or equivalent.
6. Reference Attenuator - Wavetek 10, 1, 0.1 or equivalent.
7. Variable Termination - Wide Band Engineering A56T75 or equivalent.
8. Interconnecting Cables (as required)
9. Oscilloscope (10 MV, 2 MHz min) Tektronics 604 or equivalent.
10. RMS Voltmeter - Hewlett Packard 3400A or equivalent.

B. Procedure

1. Calibration - (Method A - Calibrated Mismatch)

   a. Connect test equipment as shown in Figure 1.
   b. Turn power switches ''on'' and allow 10 minute warm-up.
   c. Set oscilloscope sensitivity to 10 MV (vertical) and adjust Horizontal gain to fill scope screen.
   d. Adjust sweep width control to display 5-300 MHz.
   e. Adjust oscilloscope intensity and focus controls for sharp traces.
   f. Set reference attenuator for 30 dB and place 30 dB calibrated mismatch on bridge test port.
   g. Set RF bridge to 75 and adjust bridge capacitor for trace coincidence to reference trace and note that traces coincide.

2. Calibration (Method B - Shorted Reflection)

   a. Complete steps III. B. 1. a thru e.
   b. With bridge test port shorted (100% reflection, 0 dB return loss), adjust reference attenuator for O dB and note that traces coincide.
   c. Place 30 dB in the reference path and proceed with test procedure.

3. Measurement Technique (General - Observe Figure 1)

A. The bridge used for this measurement is equipped with both resistance and capacitance adjustments allowing the bridge to be matched to the average cable characteristic impedance. Measurement variable bridge as well as the same adjustment of the variable far-end termination. Bridge and far-end termination balance are adjusted for minimum RMS voltmeter reading.

B. Since most detector/attenuator systems are unable to respond fully to fast rise-time spikes (very high frequency spikes) proper system response is assured when either sweep-width or sweep-speed of the system is reduced to permit maximum detector response and output (greatest average structural return loss).

C. With sweep controls set for full scale display of 5-300 MHz and RF switch set to display only the SRL pattern, adjust variable bridge arms and variable far-end termination controls for minimum RMS meter indications. Properly accomplished, minimums in the displayed trace touch the base reference line. Incorrect readings may be obtained if these adjustments are made to display minimum SRL spike indication without base line consideration.

D. SRL Measurement - Reduced Sweep-Width

a. Without disturbing variable bridge and terminator settings (para b above), reduce sweep-width to no more than 10 MHz for full horizontal scale scope indication. With "Frequency" control, manually move the observed 10 MHz sweep segment so that the entire 5-300 MHz range is displayed on the scope in sequence. Should any observed peaks closely approach the 30 dB calibrated reference line established in the calibration procedure, further reduce sweep-width to make sure no further detector response is possible.

b. If maximum reflections observed in the preceeding paragraph do not exceed the reference trace, the cable under test has better than 30 dB structural return loss for the frequency range 5-300 MHz. To measure the actual level of maximum reflections, observe instructions of the preceeding paragraph and center each major reflection in question on the scope with reduced sweep-width. The reference attenuator is either increased or decreased to move the calibrated reference line into coincidence with the reflection in question. Actual SRL for that reflection is then the value indicated by reference loss attenuator setting.

c. Repeat steps 3a through 4b for the other end of the cable under test.

E. SRL Measurement - Reduced Sweep-Speed

a. Repeat steps through paragraph 3b and without disturbing variable bridge and terminator settings, reduce sweep-speed (while maintaining full 5-300 MHz display) until observed test trace has been maximized, assuring complete detector response.

b. If maximum reflections observed in the preceding paragraph do not exceed the reference trace, the cable under test has better than 30 dB structural return loss for the frequency range 5-300 Mhz. To measure the actual level of maximum reflections, observe instructions of the preceding paragraph and center each major reflection in question on the scope with reduced sweep-width. The reference attenuator is either increased or decreased to move the calibrated reference line into coincidence with the reflection in question. Actual SRL for that reflection is then the value indicated by reference loss attenuation setting.

c. Repeat steps 2a through 3a for the other end of the cable under test.

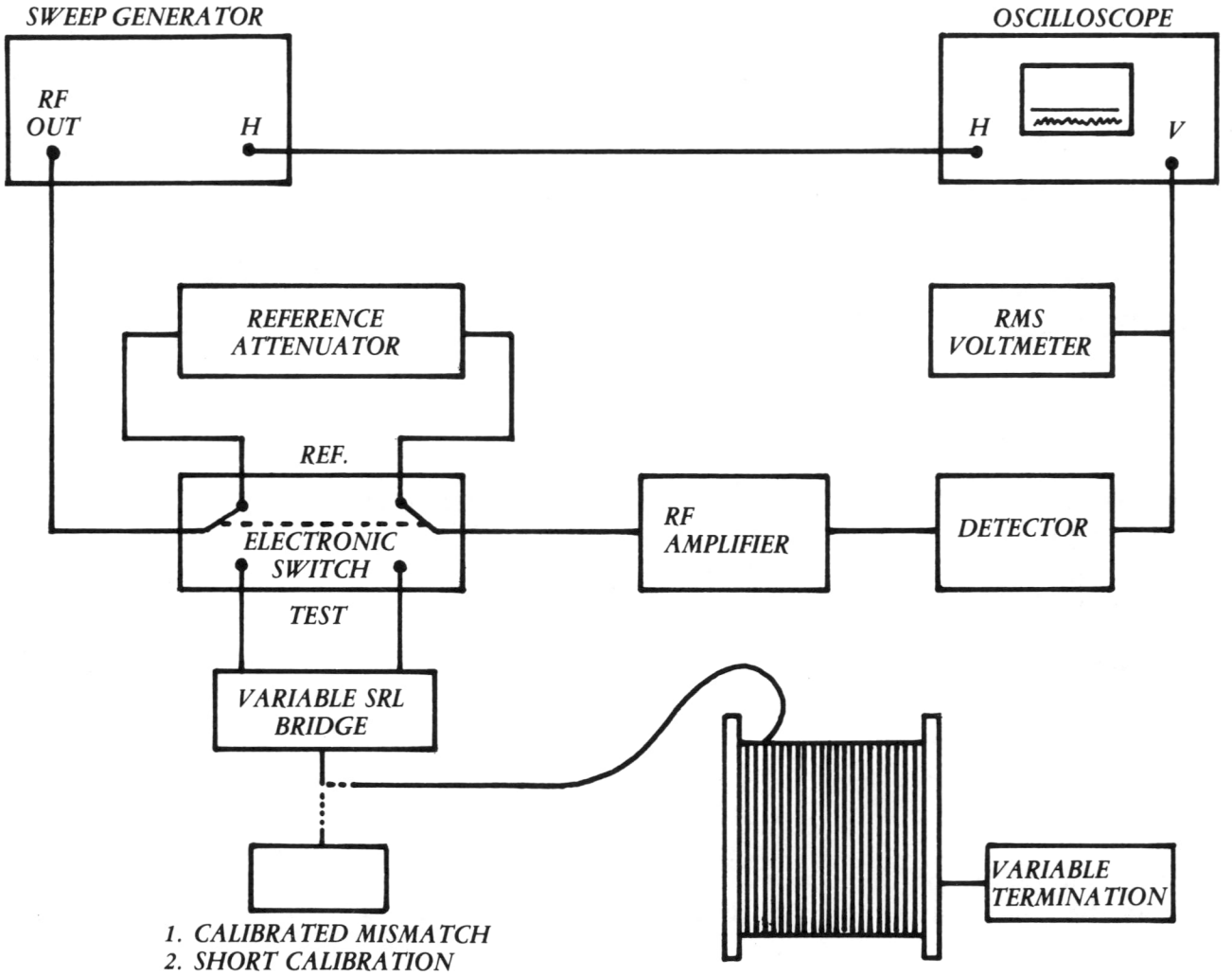

SWEEP GENERATOR
RF OUT
H
OSCILLOSCOPE
H
V
REFERENCE ATTENUATOR
RMS VOLTMETER
REF.
ELECTRONIC SWITCH
RF AMPLIFIER
DETECTOR
TEST
VARIABLE SRL BRIDGE
VARIABLE TERMINATION
1. CALIBRATED MISMATCH
2. SHORT CALIBRATION

FIGURE I

COAXIAL CABLE INSERTION LOSS (SWEEP TEST)

I. SCOPE

This procedure describes a method of measuring the insertion loss of a coaxial cable in the frequency range of 5-500 MHz.

II. PREPARATION OF TEST SPECIMENS

Cable of such lengths as specified by order or specification shall be prepared by fitting cable ends with either standard connectors of proper impedance characteristics or with appropriate type N75 modified slip fittings.

III. METHOD

A. Equipment

1. Sweep Generator - Wavetek 1801 or equivalent
2. RF Switch)
3. RF Amplifier) Wide Band Engineering A51 Analyzer or equivalent.
4. Detector)
5. Reference Attenuator - Wavetek 10 db, 0.1 db or equivalent
6. Oscilloscope (10 mv, 2 MHz minimum band width)
7. Interconnecting cables and cable connectors as required
8. Oscilloscope Amplifier - (if required)

B. Procedure

1. Connect equipment as shown in Figure 1.
2. Turn power switch on and allow 10 minutes warm up. Adjust scope controls for a clear sharp trace.
3. Set the sweep width control and the center frequency control on the oscillator to display the range of measurement desired on the scope face.
4. Short the cables coming from the RF switcher (Channel B) using the appropriate type shorting adaptor.
5. Turn the Reference Attenuator to 0 db loss and insure both the ''Reference'' trace and the ''Test'' trace coincide.

NOTE: Adjustments may be made on the scope amplifier vertical controls and/or the RF output of the Wavetek oscillator to get an ''on screen'' trace.

6. Remove the shorting adaptor used in Step 4 above and connect the leads from the RF switcher to the prepared ends of the cable under test.
7. Using the Reference attenuator, re-establish the coincidence of the traces at the frequency of interest. The oscillator sweep width control, center frequency, and fixed markers may be used to establish the frequency at the point of coincidence.
8. If needed, the RF output power may be increased to obtain a precise measurement at higher frequencies. The oscilloscope vertical amplifier may also be used to increase the sensitivity of the measurement.
9. Record the attenuator setting and frequency at the point(s) of coincidence.

IV. CALCULATIONS

A. Attenuation is directly proportional to length and conversion to db/100 feet is given by:

$$\text{Atten. in db/100 Ft.} = \frac{100 \text{ X Atten. (db/L)}}{\text{L}}$$

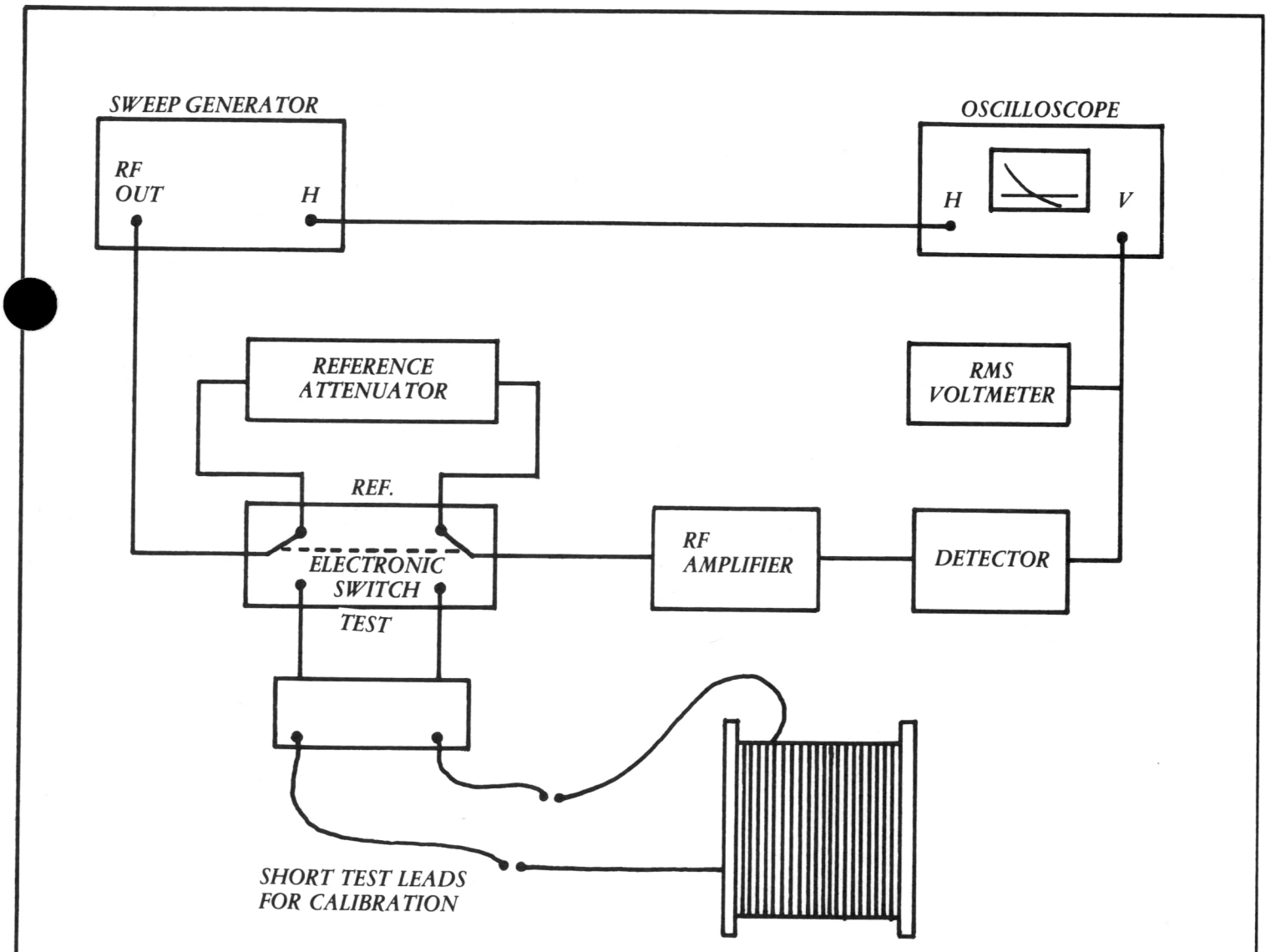


FIGURE I

Cable Handling Tools

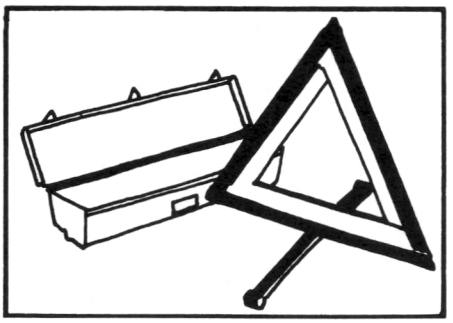
TOOLS AND EQUIPMENT

The tools and equipment shown and described on the following pages are representative of the items crew members use while working on cable television systems. There are also other specialty items used which are not included.

These tools and equipment are available from various cable television and telephone suppliers and distributors. Consult your supervisor or purchasing agent for part numbers and ordering data.

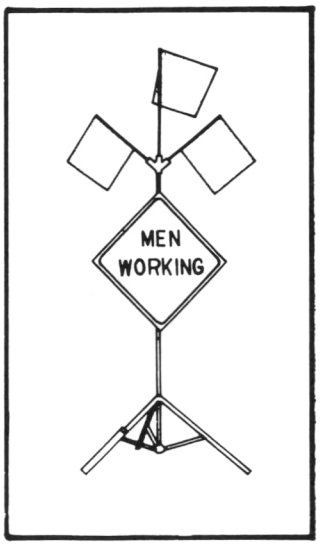
The vehicles required to transport these tools and equipment are not included in this listing because these vehicles vary in type and specifications in different circumstances and locations.

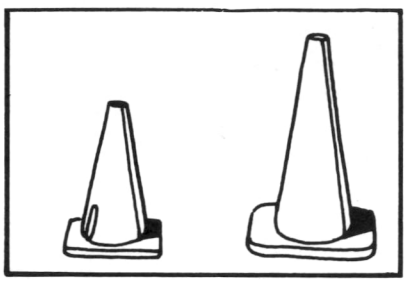
SAFETY
TOOLS AND EQUIPMENT



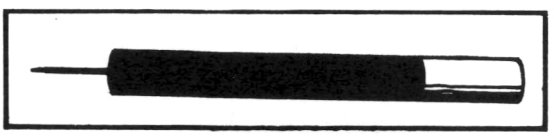
Safety Equipment - The traffic control and safety equipment illustrated is used to protect crew members, the public, and the cable plant from harm during the installation process.

Folding Reflectors

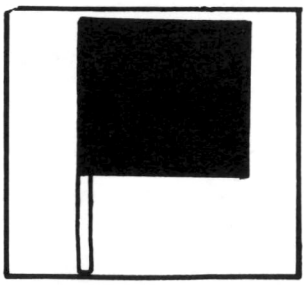




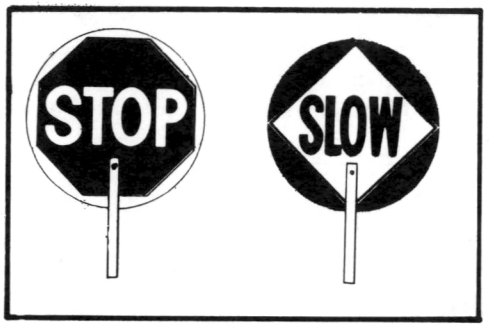
Traffic Cones



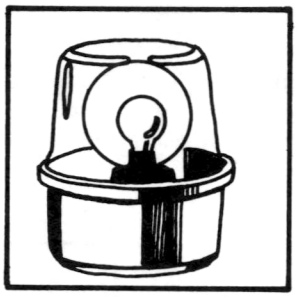
Burning Flares



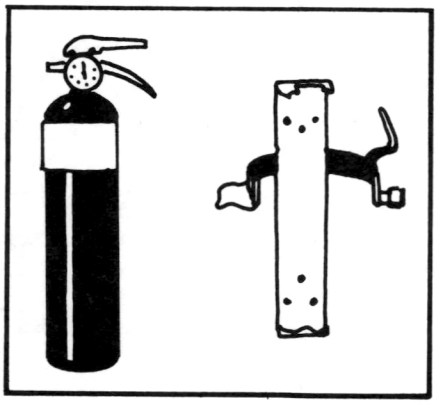
Warning Flags are used in conjunction with warning signals on vehicles and signaling for directing traffic.



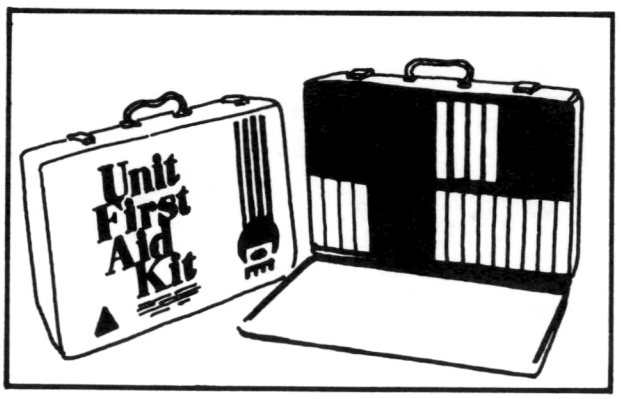
Traffic Signals are used at traffic control points on road construction sites, in familiar shapes and colors which are easily recognized by motorists. Signs are of light-weight, corrosion-resistant, weather-proof materials with no sharp edges. Models come in 15 in. diameter with bold 5 in. high letters.



Amber Rotating Beacon Light is installed on the Vehicle and is used to warn on-coming traffic of activity around the vehicle.

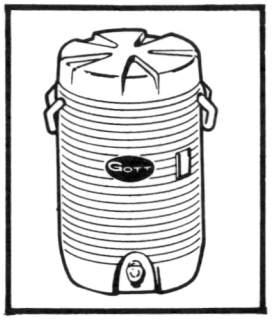


CO^2 Fire Extinguisher is U/L rated safe for electric fires and also extinguishes gasoline, oil, grease, kerosene, tar and rubber fires. This unit is installed on the vehicles for fire protection.

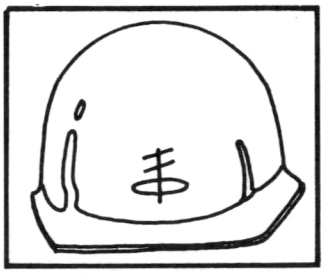


First Aid Kits of adequate size must be maintained in all vehicles and work areas. Snake bite kits etc. should be available where required.

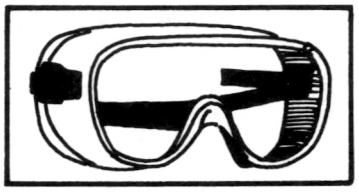
Volt Ohm Meter is used to measure voltage and resistance along the cable routes.



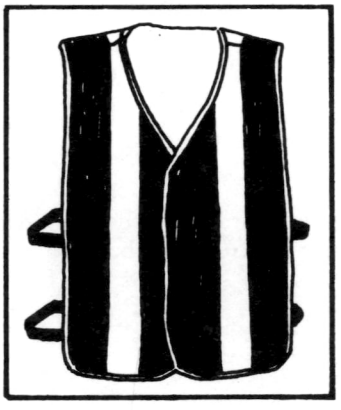
Water Cooler is installed on the vehicle for crew water supply.



The Hard Hat is a safety hat designed for persons exposed to electrical hazards and falling objects.

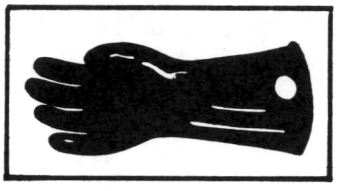


Safety Goggles should be worn to protect eyes from injury.

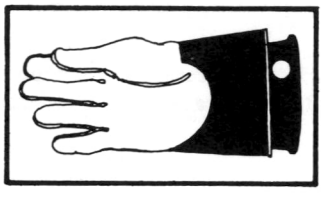


Traffic Vests have highly visible fluorescent strips and should be worn when working near hazardous traffic areas.

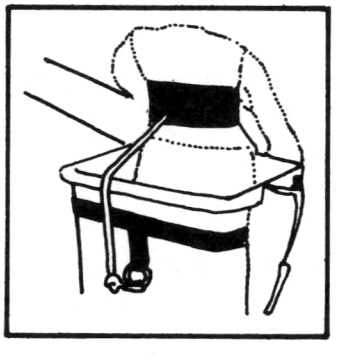
High Visibility Rainsuit is protective clothing worn over regular clothes during inclement weather.



Climber's Rubber Gloves will give protection against electrical shock. Consult manufacturer's recommendations for care and periodic testing.

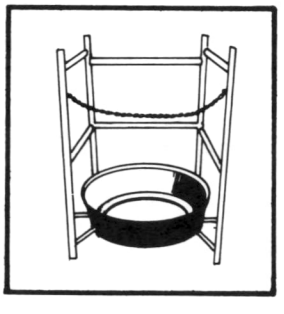


Climbers Protective Gloves are worn over rubber gloves for protection against damage.



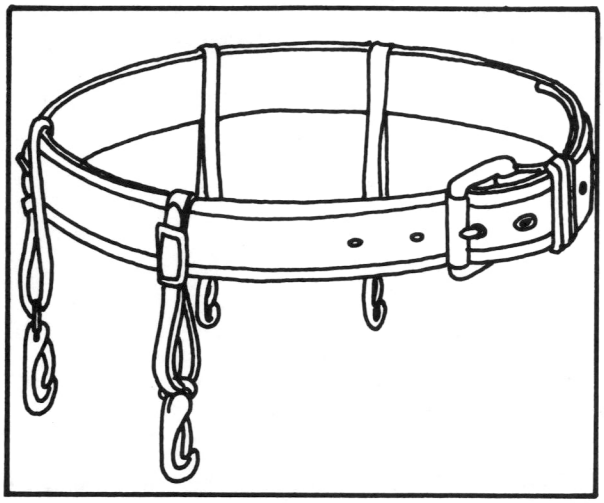
Aerial Bucket Safety Harness is used as an attachment to aerial buckets and is used as a body belt and safety strap for crew members.

Manhole Ventilator is used to circulate fresh air into a manhole for crew members.



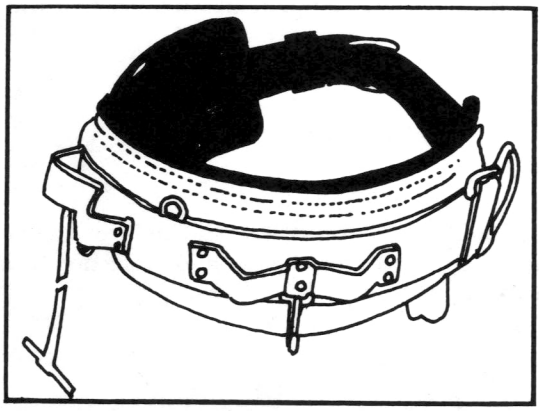
Safety Fence and Manhole Shield is used to keep the public and crew members from falling into open manholes.

CREW PERSONNEL
HAND TOOLS

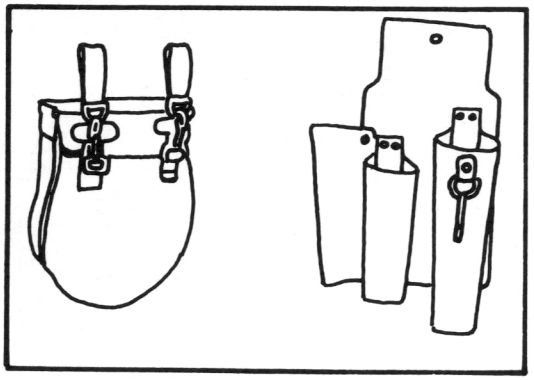


CLIMBING TOOLS

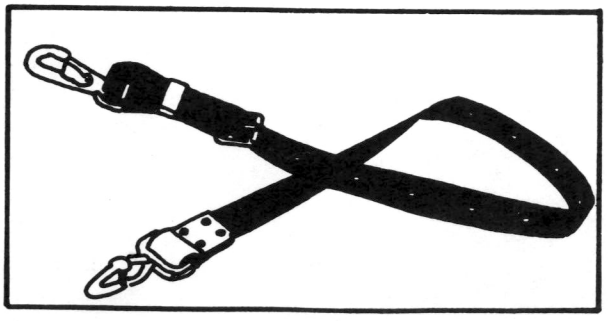
The Waist Belt Supporter is used for additional support for the body belt thus lessening body fatigue. It also allows for more mobility when working.



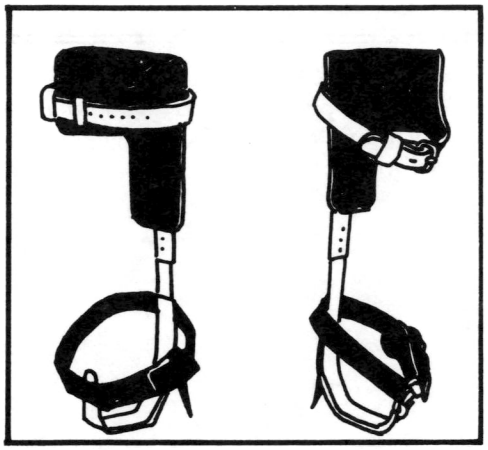
The Body Belt is provided to personnel when working at elevations more than 4' above ground on poles, towers, etc. The size is marked in "D" sizes, which is the distance around the body measured at the prominent points of the hip bones, plus one inch.



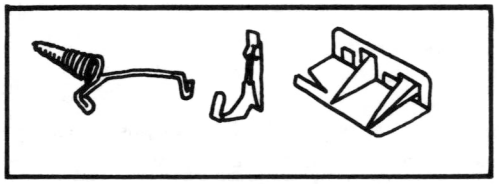
The Nut and Bolt Bag and Tool Holster are attached to the body belt and used for storage of parts and tools.



The Safety Strap is used for support while working on poles, towers or platforms. It should be checked at least semi-annually by the supervisor and examined by the employee each time before use.

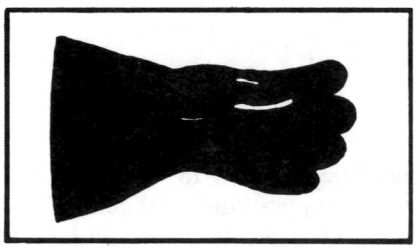


Climbers are furnished for work on wood poles. The proper gaff gauge and sharpening instructions are available from the manufacturer. Climbers should be checked frequently for wear and possible damage.

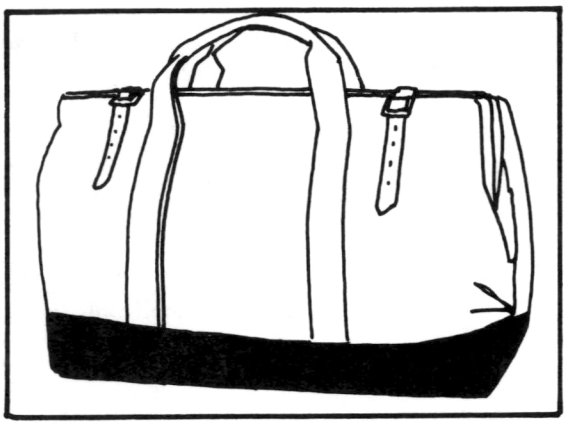


Gaff Guards should be used when storing climbers. Gaff Gauges are required for periodic checks and sharpening of gaff.

Line Boots are specifically designed to accommodate climbers for maximum support and protection for the feet and legs.

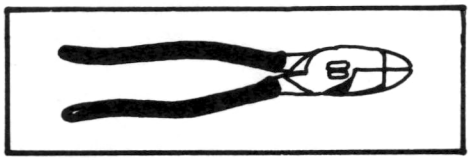


Line Gloves provide protection for the hand and wrist area.

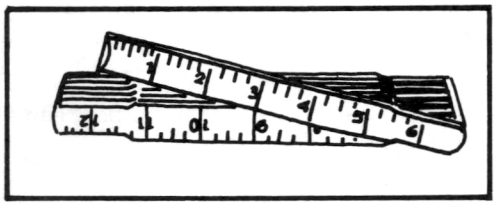


Line Tool Bag is used for storage and transportation of climbing tools.

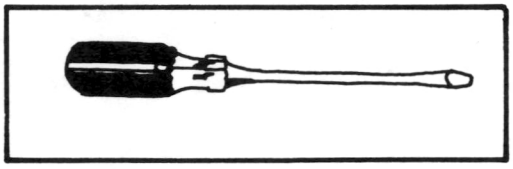
GENERAL PURPOSE TOOLS



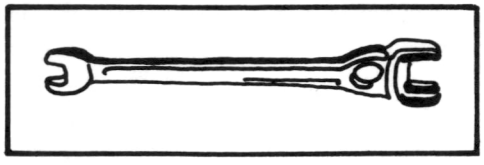
Electrician's Plier is a general purpose hand tool.



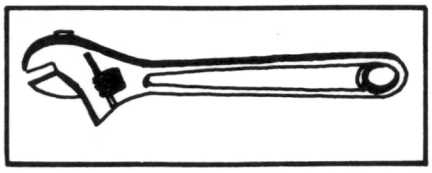
Wooden Ruler is used for measuring safe clearances prior to placing support hardware. Metal rulers should not be used.



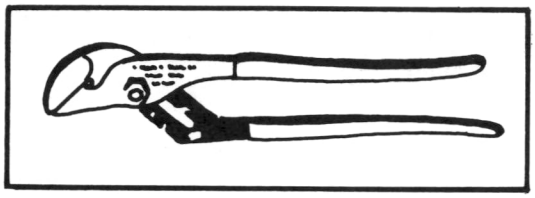
Screw Driver is a general purpose hand tool available in a variety of sizes.



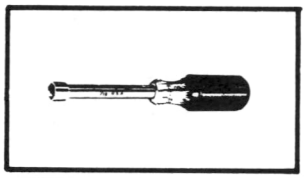
Line Wrench is used to tighten all suspension clamps and two and three bolt clamps.



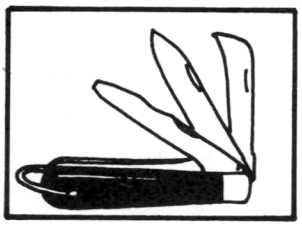
Adjustable Wrench is a hand tool used in a variety of sizes as required.



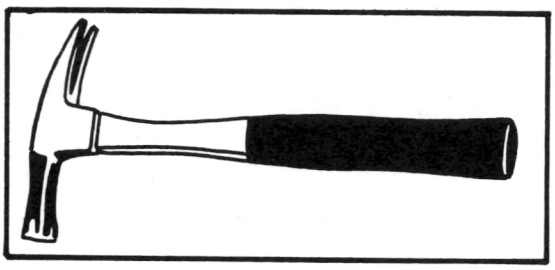
Insulated Handle Pump Plier is a general purpose hand tool.



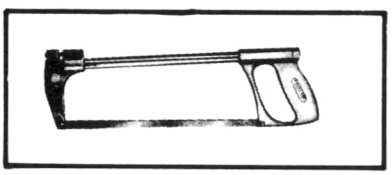
Nut Driver Set is used for all small bolt loosening and tightening.



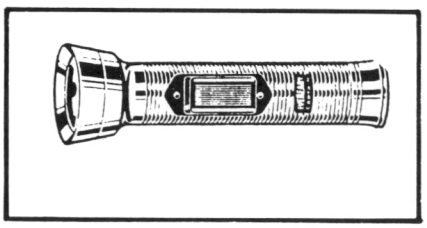
Line Knife is a general purpose hand tool.



Heavy Duty Hammer is a general purpose hand tool used for drive hooks, staples, etc.

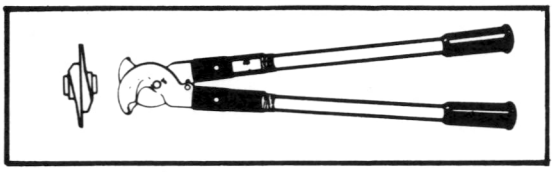


Electrician's Saw is used for cutting all metal items as required.

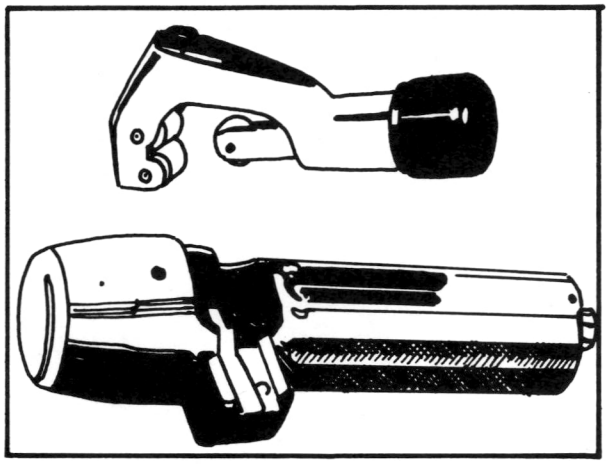


Flashlight is used as required.

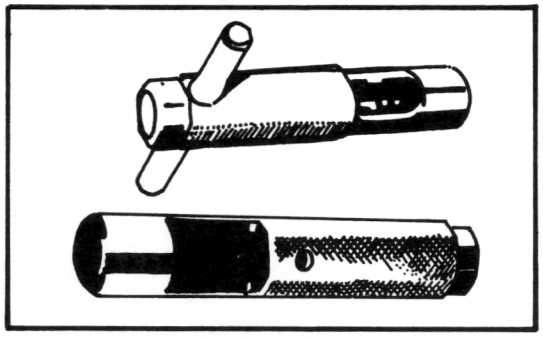
SPLICING TOOLS



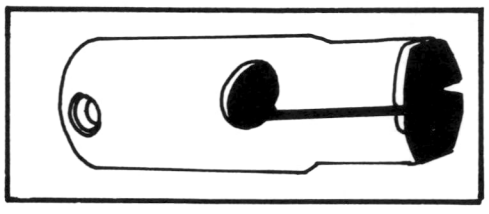
Cable Cutter is used to cut larger size cables.



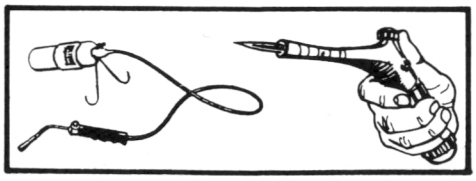
Tubing Cutter or a cable preparation tool is used for cutting the jacket and aluminum sheath off cable ends during the splicing process.



Coring Tool is used for coring out the dielectric of the tube cable to accommodate the connectors during the splicing process. There is a coring tool for each size of cable.

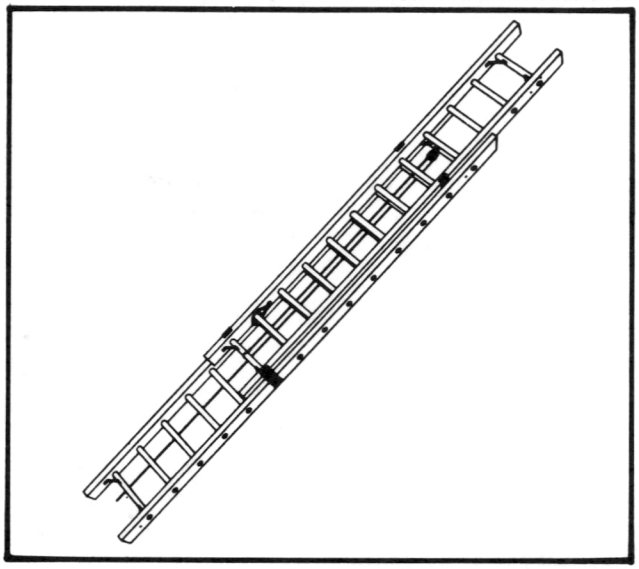


Center Conductor Cleaner is used to remove the small amount of dielectric adheared to the center conductor of coaxial cable after coring.

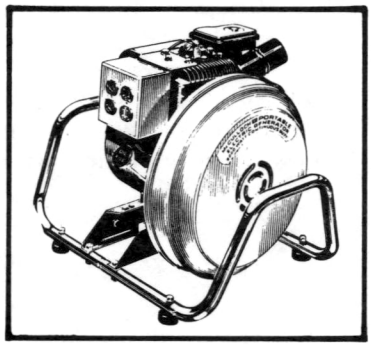


Heating torch is used for heating heat shrinkable tubing onto cable and connectors while splicing cable.

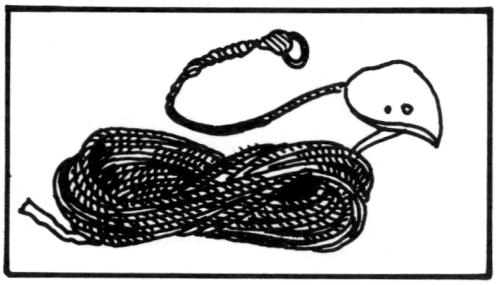
VEHICLE AND STRAND TOOLS AND EQUIPMENT



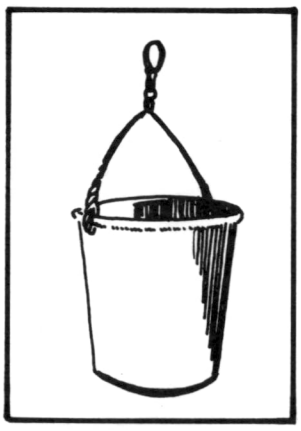
Extension Ladder is made of wood or fiberglass and is available with various utility accessories. Length should be determined so climber can stand no higher than the 4th rung from the top when fully extended for the required working height.



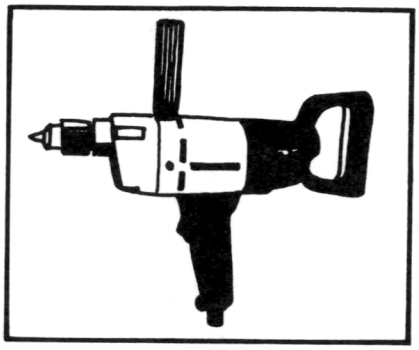
Portable Electric Generator is available up to 5000 watts and should be selected based on power requirements.



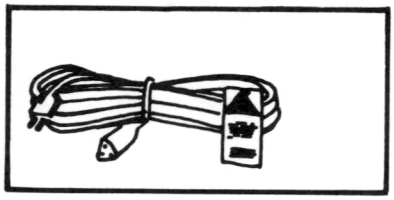
Hand Line is used for transferring tools and materials between the ground and the climber working on the pole.



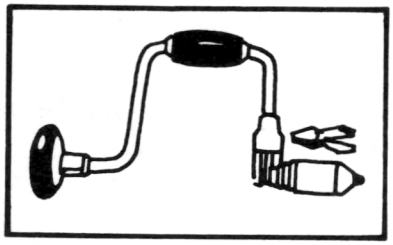
Tool Bucket is used for carrying parts and tools to the climber via a hand line while working on the pole.



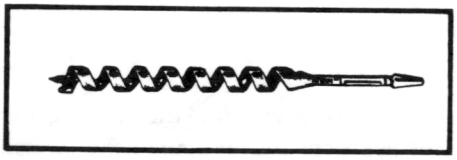
1/2'' Electric Drill is low speed/reversing for drilling poles, etc.



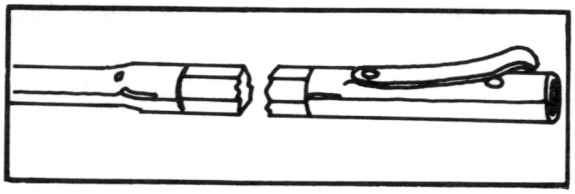
Heavy Duty Extension Cord is a three-wire cord grounded in required lengths.



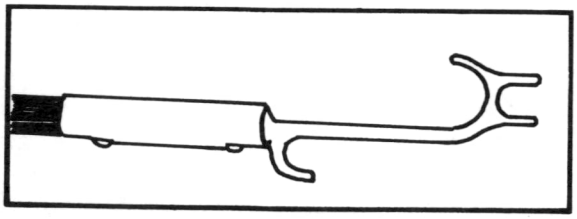
Brace is used when an electric drill is impractical.



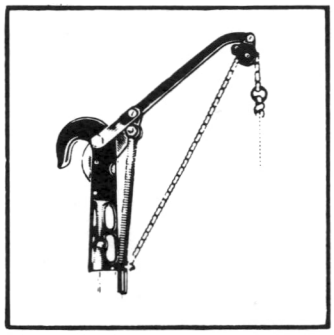
Pole Bit is designed to bore through creosoted poles without clogging or binding and can be used with brace or electric drill.



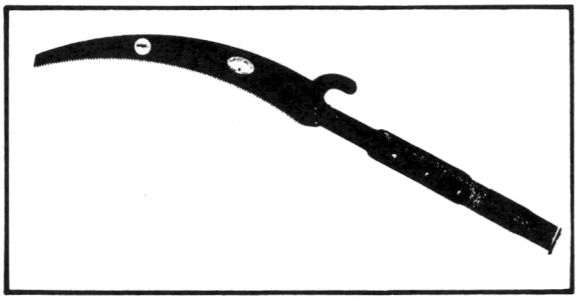
Lay-up Stick is available in 4, 6 and 8 ft. sections made of fiberglass or wood.



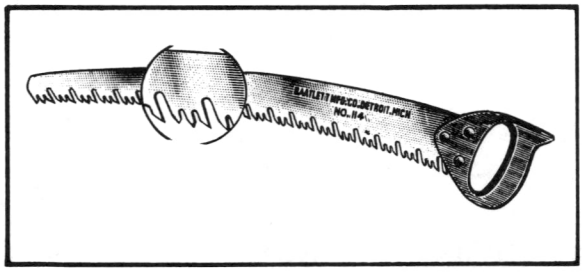
Wire Raising Tool is attached to an insulated lay-up stick for light pruning from the ground.



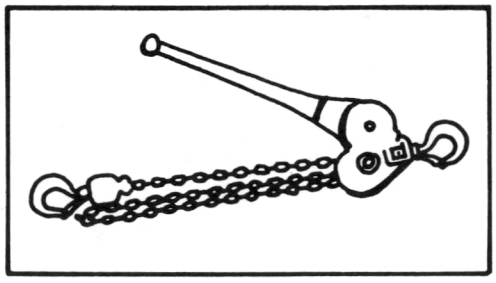
Tree Pruner Head is attached to an insulated lay-up stick for light pruning from the ground.



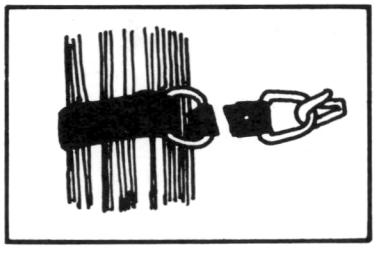
Tree Pruner Saw is attached to an insulated lay-up stick for heavy duty pruning from the ground.



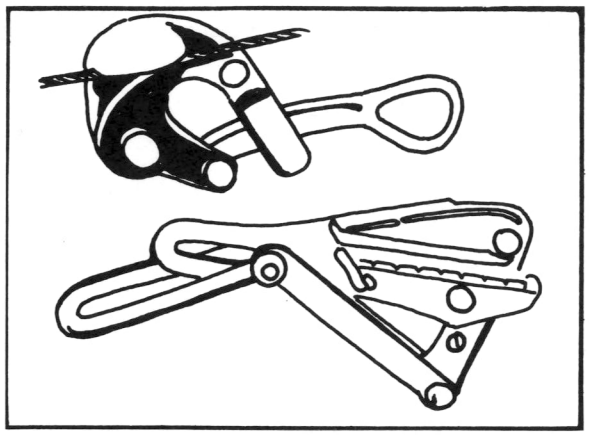
Rapid Cut Pruner Saw is used for heavy-duty tree trimming.



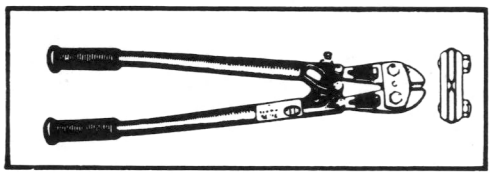
Chain Hoist is used to attach to the messenger or wire grips at deadend locations for tensioning the messenger strand or wire. The hoist is also used for removing portions of the strand or wire in order to provide expansion loops in IM cables.



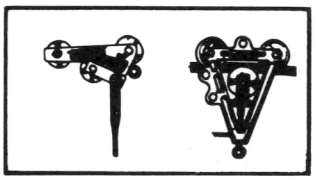
Pole Sling will provide a temporary attachment at any point on a pole for a hoist, hand line block, etc.



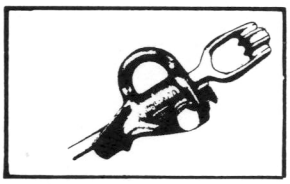
Messenger Grips are grips utilized for stranded type messenger or for bare wire type messenger. They are used in conjunction with the hoist for tensioning the messenger at deadend locations etc.



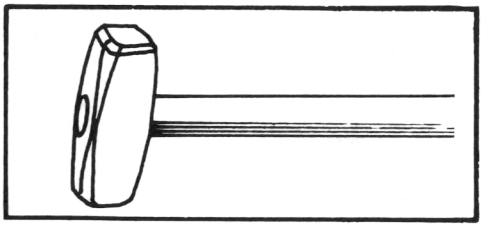
Bolt and Wire Cutters are used to cut the messenger strand or wire and large cables where required.



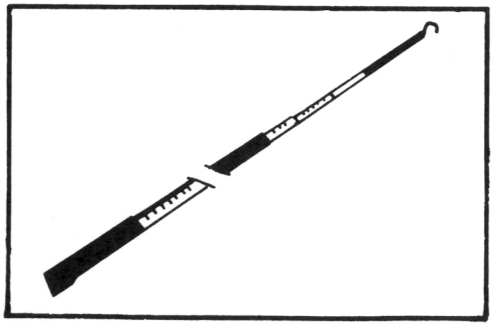
Traveling Ground attaches to the strand during installation to prevent possible electrical shock.



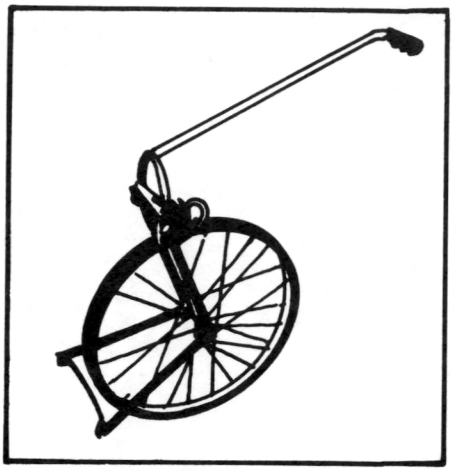
Pulling Eye is used for installing guy grips on anchor rods with hoist.



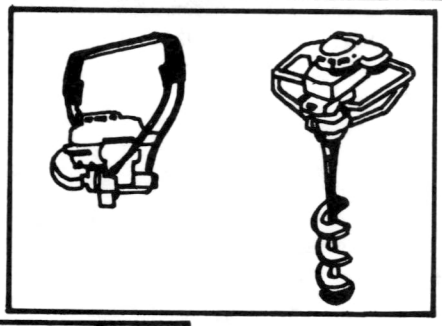
Sledge Hammer is used for driving ground rods, etc.



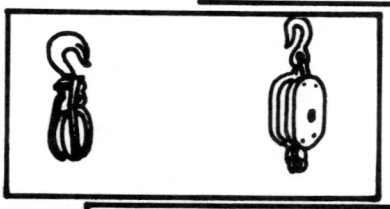
Insulated Measuring Stick is used for measuring aerial clearances while standing on the ground.



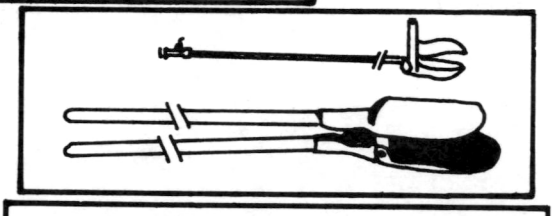
Measuring Wheel is used to measure distances as required.



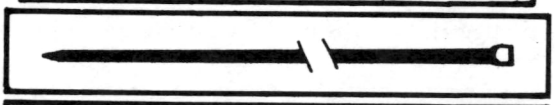
Power Auger Motor is used to drill pole and anchor holes and to drive screw anchors into normal soil.



Snatch Blocks are available in various sizes and configurations for hand lines, etc.

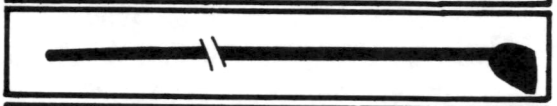


Telescoping Auger
or
Post Hole Digger



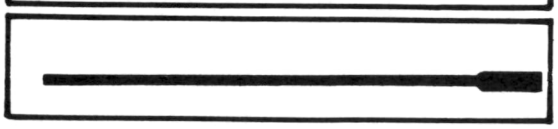
Digging Bar

Digging Shovel



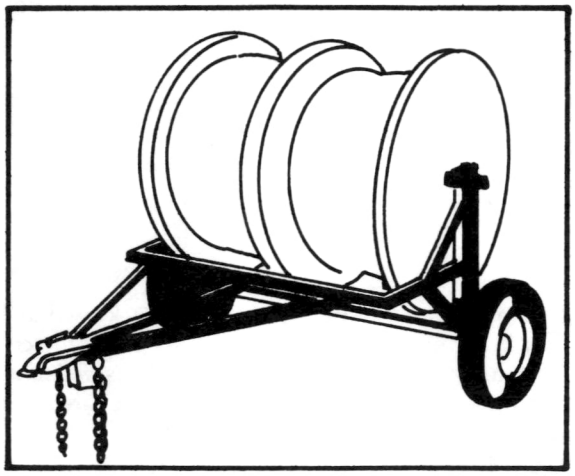
Spoon Shovel

Backfill Shovel

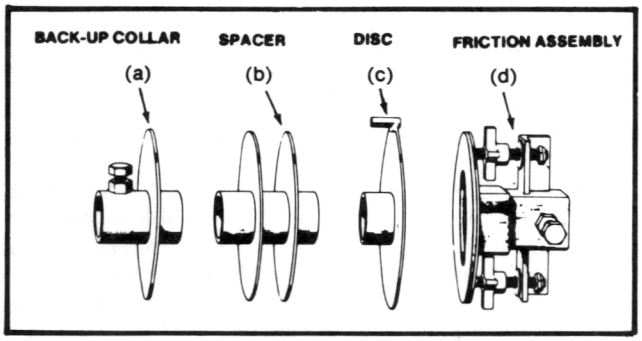


Tamping Bar

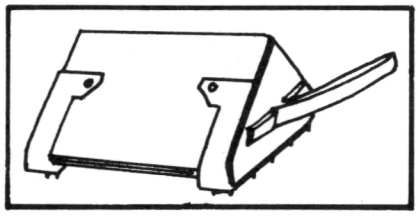
CABLE HANDLING
TOOLS AND EQUIPMENT



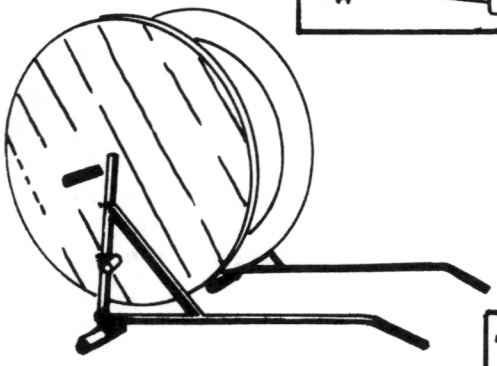
Cable Reel Trailer is similar to the one pictured and is available from many different manufacturers and ranges from the single-axle type shown to more sophisticated units capable of carrying many more than 2 reels at one time. Selection of the proper reel trailer for your project is important.



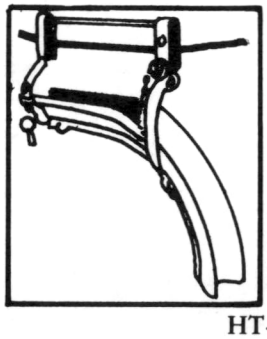
Reel Brake is attached to the cable reel supporting bar of the cable trailer. The brake has tensioning adjustment for control of the payout tension of the cable off the reel trailer.



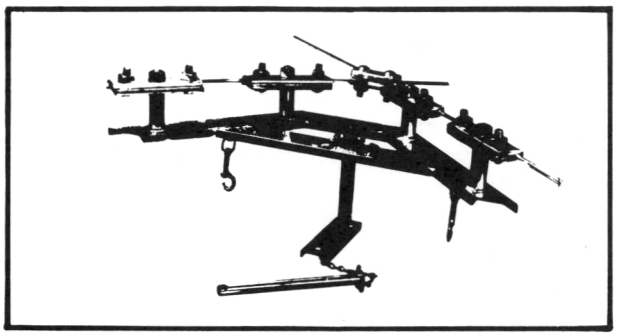
Cable Trailer Chocks are wheel chocks used behind the cable trailer tires to prevent the trailer and/or truck tires from moving during the cable pulling process.



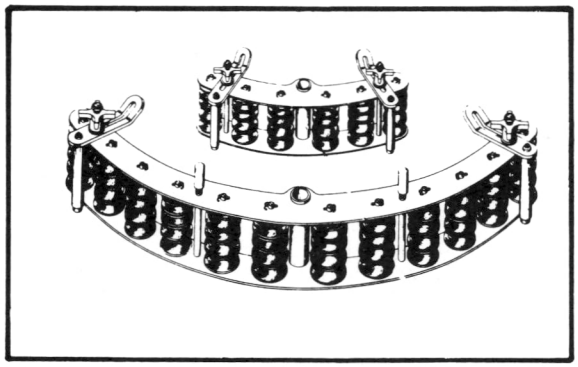
Cable Reel Stand is utilized in locations inaccessible to vehicles and trailers or where additional reels of cable are necessary and cannot be accommodated by the reel trailer.



Aerial Cable Guide - The aerial cable guide is placed on the strand in front of the Cable Positioner and/or Lashing Machine to guide the cable(s) off the reels.

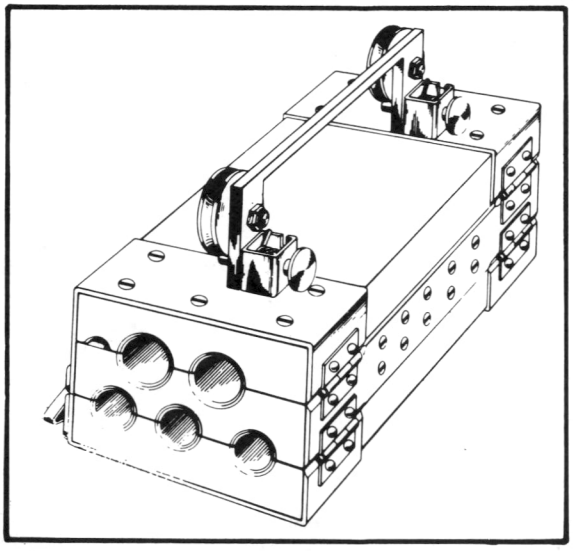


Corner Block Attachment is fastened to the strand on corners to support the 45° and 90° corner blocks (rollers).

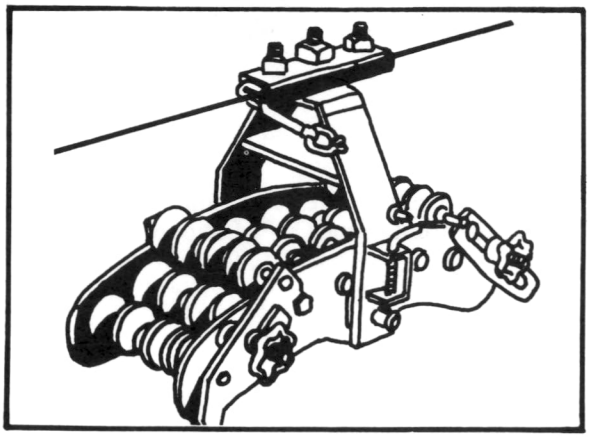


45° Corner Block is a multiple corner block used at locations where the cable turns from 5-45°. It protects the cable from damage of severe bending radii as well as maintains proper cable separation where multiple cables are being pulled. (Also used as a cable chute.)

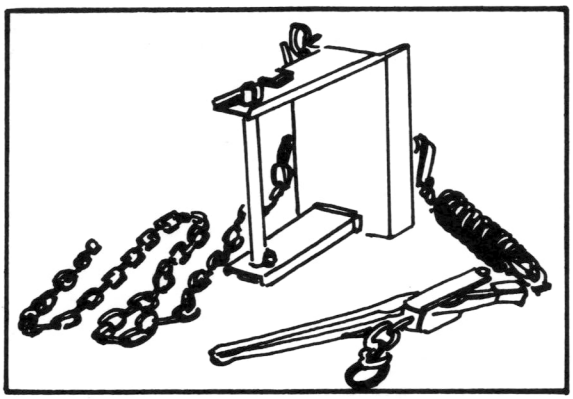
90° Cable Block is a 90° corner block used at locations from 45 to 90° ang serves the same purpose as the 45° corner block described above.



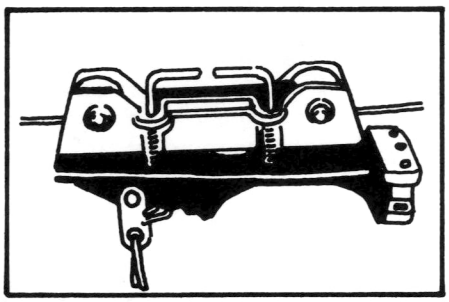
Multiple Cable positioner is placed on the strand in front of the cable lashing machine and the cable is placed into the positioner at the desired cable locations. As the lashing machine is pulled span by span, the cable positioner feeds the cable into the lashing machine, thereby maintaining uniform positioning of the cables.



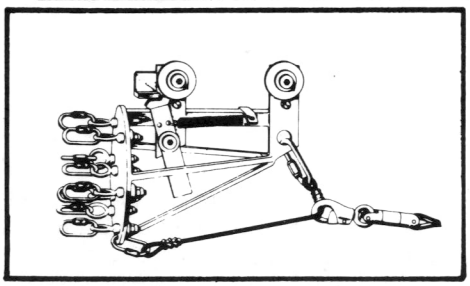
Strand Chute Bracket is utilized in conjunction with a 45° corner block for receiving the cable from the reel trailer at the strand level where the cable pulling process begins.



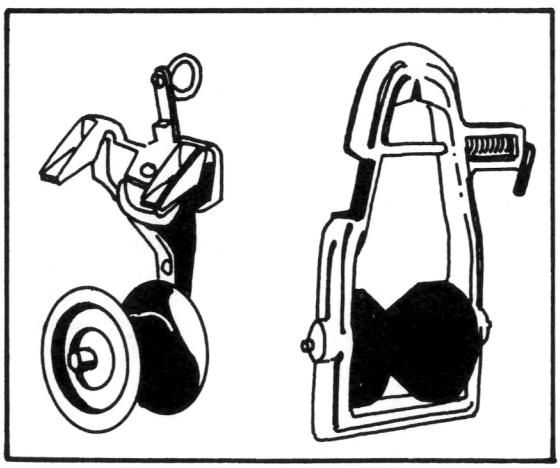
Pole Attachment Bracket is utilized to anchor the 45° and 90° corner blocks secure to poles where required.



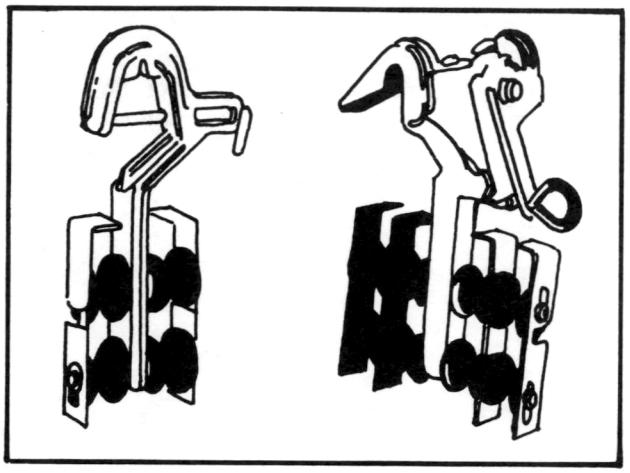
Cable Puller is used to pull cable into place prior to the lashing operation.



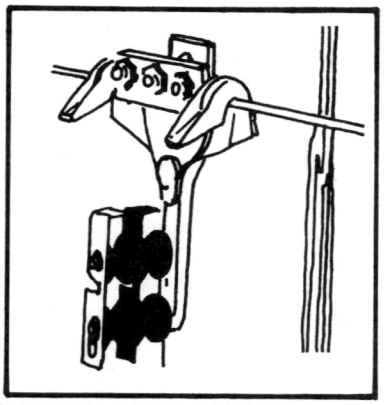
Multiple Cable Puller is placed on the strand with a pull line attached. The rotating eye pulling grips are attached to the eyelets on the cable puller. The cable puller keeps multiple cables properly separated as they are pulled into place for lashing.



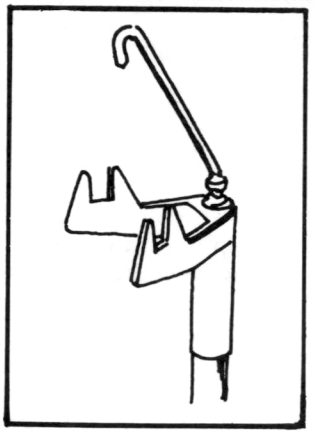
Single Cable Blocks (Rollers) are used at poles and mis-span locations at approximately 50 ft. intervals. They are necessary to support the cable as it is pulled into place for lashing.



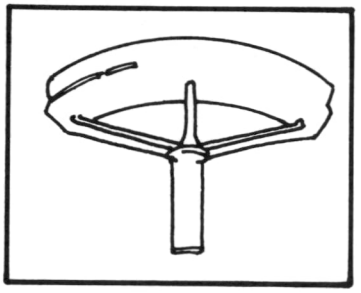
Multiple Cable Blocks (Rollers) are used in the same manner as single cable blocks. They are available in configurations to accommodate from 2 to more than 10 cables.



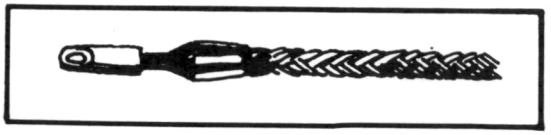
Cable Block Rod is usually supplied by the customer or contractor. It is a ¼'' smooth steel rod approximately 16'' long. These rods are clamped in the suspension clamps at the poles for supporting standard cable blocks.



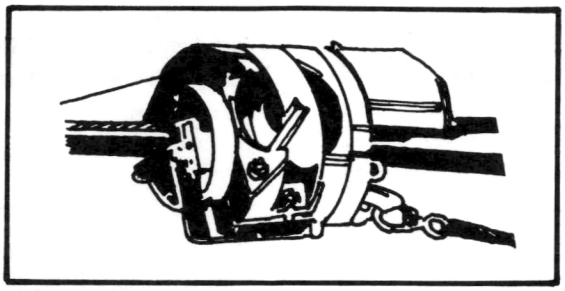
Cable Block Lifter is made by each manufacturer of cable blocks or follers. These lifting tools fit their cable blocks. These tools are used at the end of lay-up sticks for placing the cable blocks onto the strand.



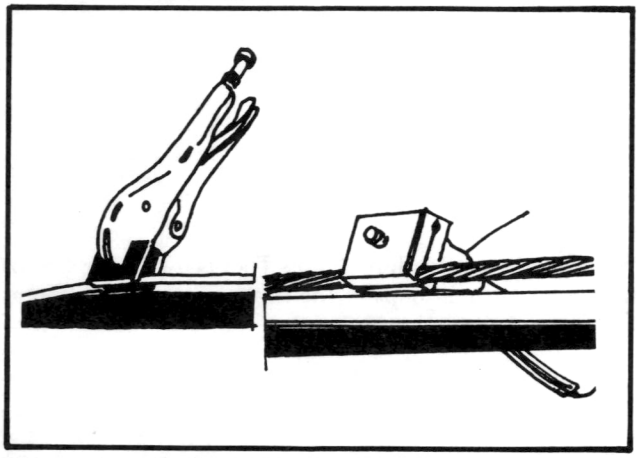
Cable Lifter is a tool used on the end of layup sticks for placing the cable into the cable blocks at misspan locations without damaging the cable.



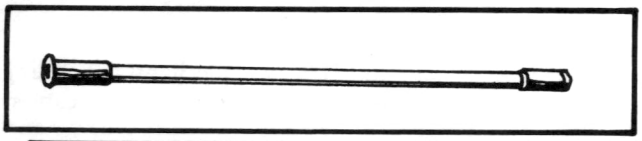
Rotating Eye Pulling Grips are pulling grips available from several suppliers. They are slipped onto the end of each reel of cable to be pulled, later to be attached to a rope or cable puller after passing through the cable chute.



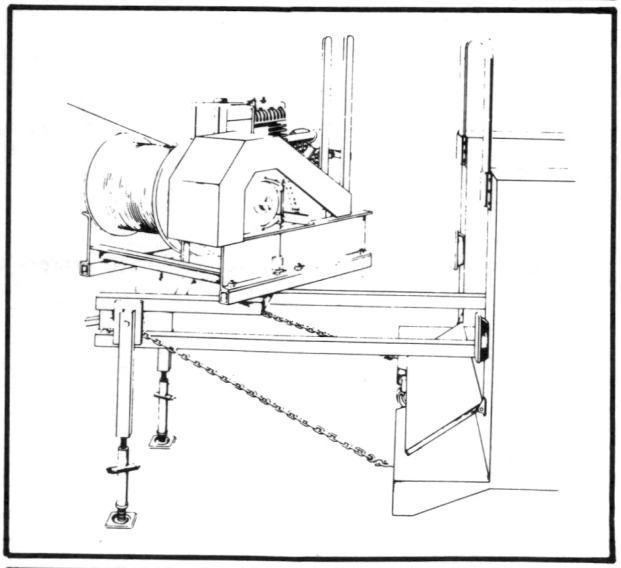
Cable Lashing Machine (either the general machine product, lashing machine or equivalent) should be used for lashing the cable. There are 2 basic sizes of machines utilized. The "C" lasher will accommodate cables up to 1 5/8" in diameter. The "J" lasher which supersedes the "F" lasher will lash a cable package up to 3¼" in diameter.



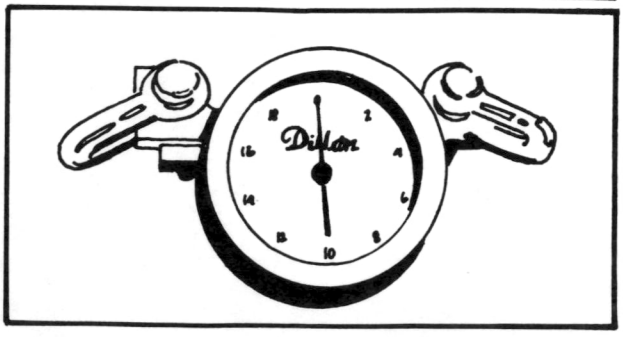
Catch Off Clamp is used to temporarily hold the lashing ware in place while the workmen transfer and/or remove the lashing machine from the poles. There are two types available. The handle tightening type and the vice grip type.



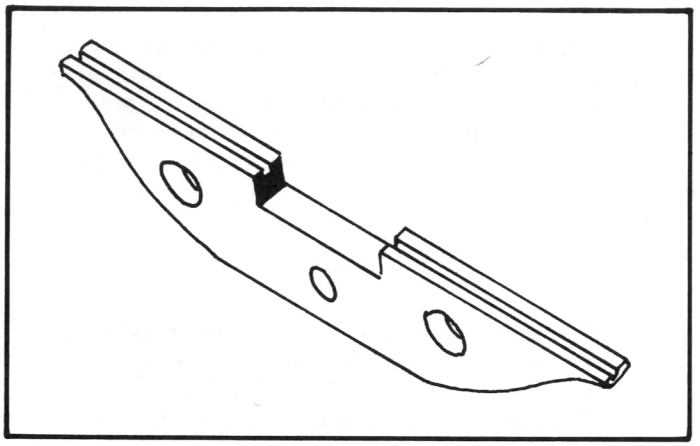
Cable Block Pusher is placed on the strand immediately in front of the lashing machine or multiple cable positioner. The block pusher spaces and pushes the cable blocks located at the midspan locations to the pole for removal as the cable is being lashed span by span.



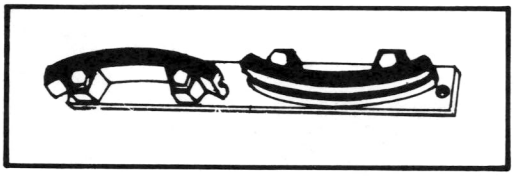
Winch is equipped with aircraft cable. The winch is also equipped with its own engine and can be mounted on trucks, pickups or vans. The winch should be utilized for pulling multiple cable configurations for proper tensioning and speed control of the cable as it is pulled into place.



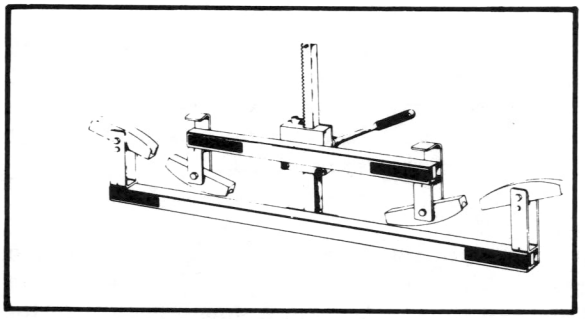
Dynamometer is a gauge which measures pounds of tension. It is placed between cable puller and the winch line on long cable pulls for monitoring the tension being placed on the cables. A dynamometer should be utilized on all cable pulls where the tension on the cable might exceed those recommended by the individual cable specification sheets.



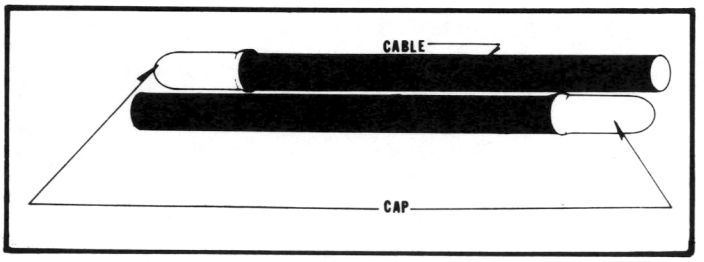
Expansion Loop Bending Tool is fabricated out of wood and is used to form expansion loops when the cable is placed.



Expansion Loop/Bending Radius Tool is used in two steps to form expansion loops in the cable. There is a different tool for each size cable.

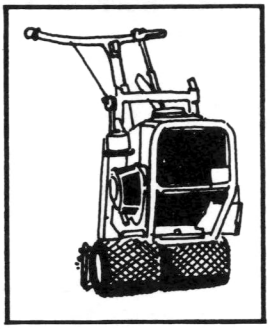


Expansion Loop Bending Tool is a mechanical bending jack used to form expansion loops in one inch (1'') cables.

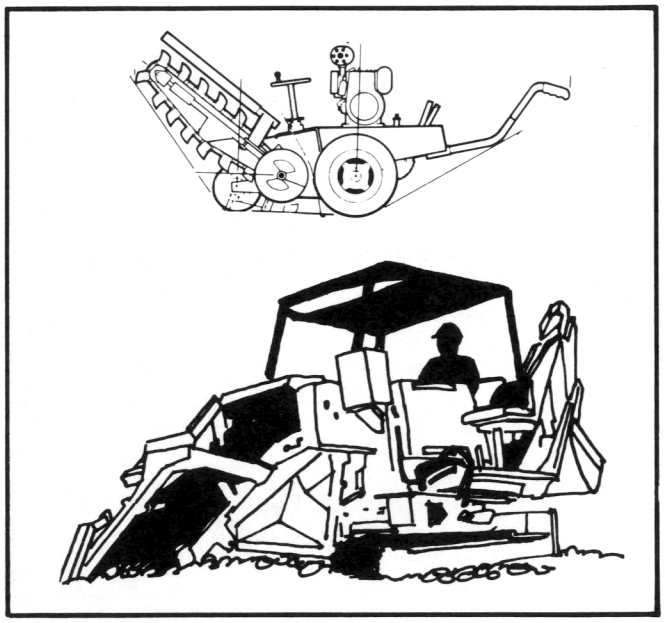


Cable Caps are used to seal the ends of cable to protect it from the elements prior to splicing.

UNDERGROUND MACHINES AND TOOLS

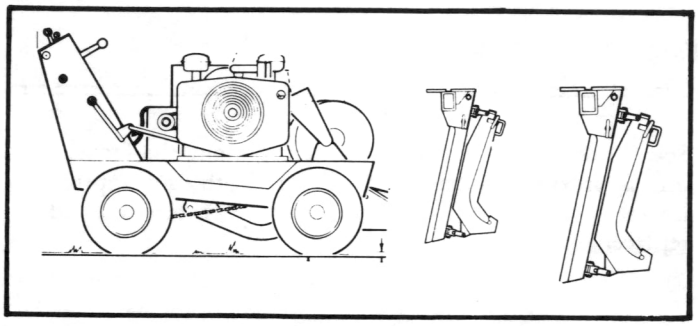


Sod Cutter is used to cut the sod (grass) along the Trench line approximately one inch (1'' in depth and approximately 12'' in width). This provides for easy removal and replacement of the sod.

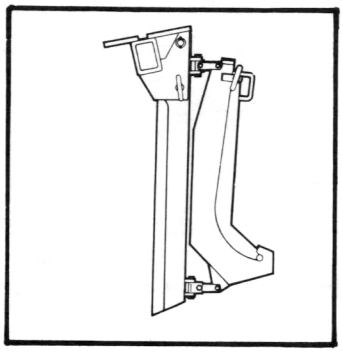


Trencher is used to dig trenches as required. They come in small walk-behind, tractor mounted, and up-to-track-mounted machines. They dig a variety of trench widths and depths.

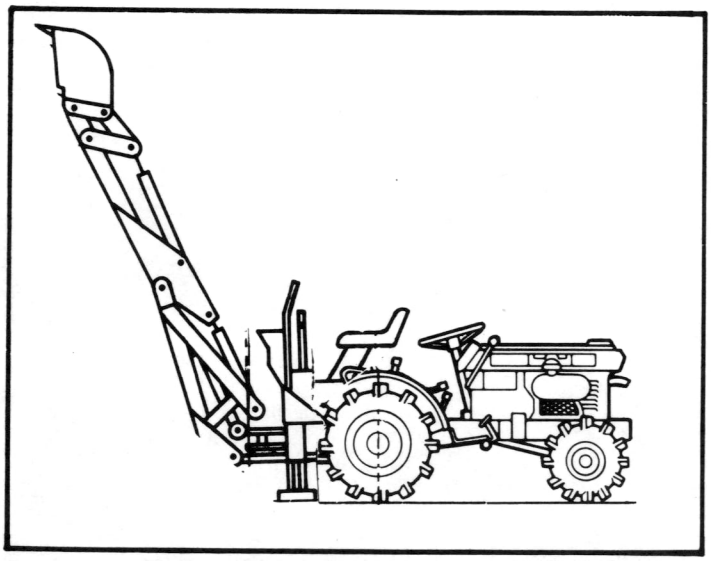
An Alligator Chain is used to replace the regular digging chain for digging frozen ground, rock and other difficult soil conditions.



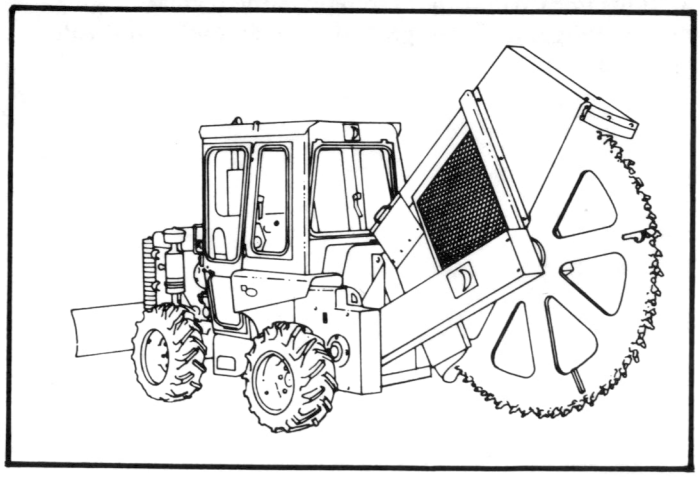
Vibrating Plow is used to plow the cable into the ground. There are self-contained units and units that attach to tractors. The blades on these plows vary in length, width and cable-handling capability.



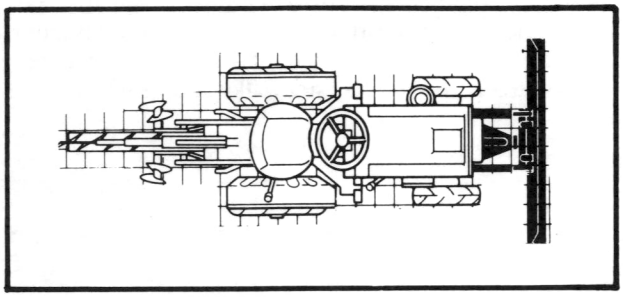
Cable Chute Attachment follows the vibrating plow blade to feed the cable into the ground without placing pulling strain on the cable.



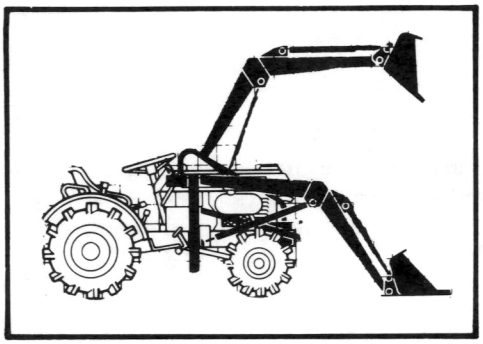
Backhoe is used for digging bore pits and other general purpose trenching jobs that cannot be dug with a trencher. This unit is available in many sizes.



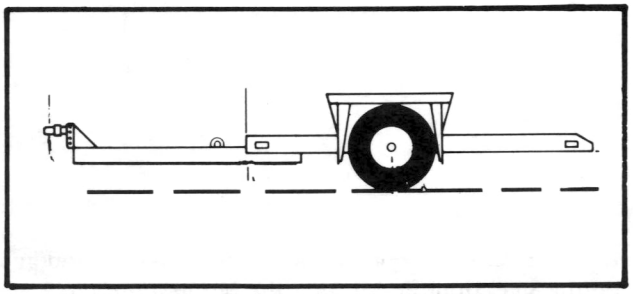
Earth Saw is equipped with special carbide revolving teeth that cuts trench in frozen earth, rocks, coral and most types of roadways. The saw is an attachment and can be replaced with a regular trencher attachment where normal soil is encountered.



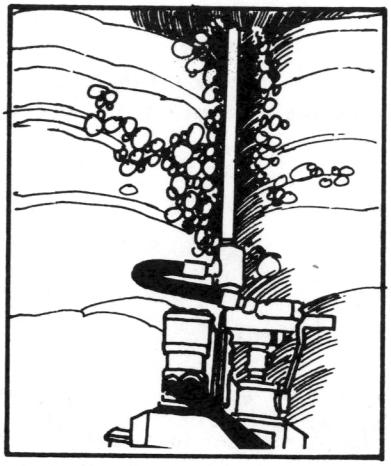
Backfill Blade is used to back fill the trench. They have right-to-left swing angle for use on both sides of the tractor.



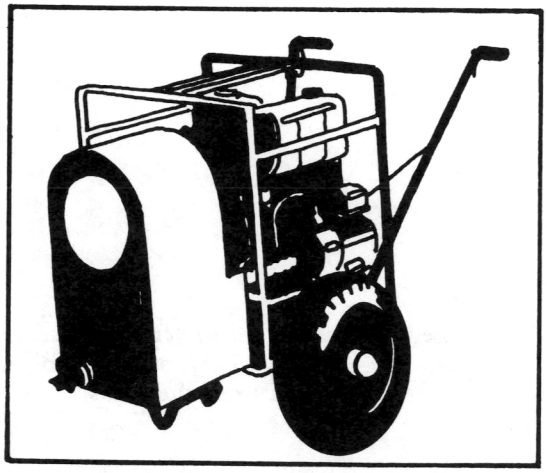
Front End Loader is used to load materials, to backfill bore pits and trench and to relocate materials as required.



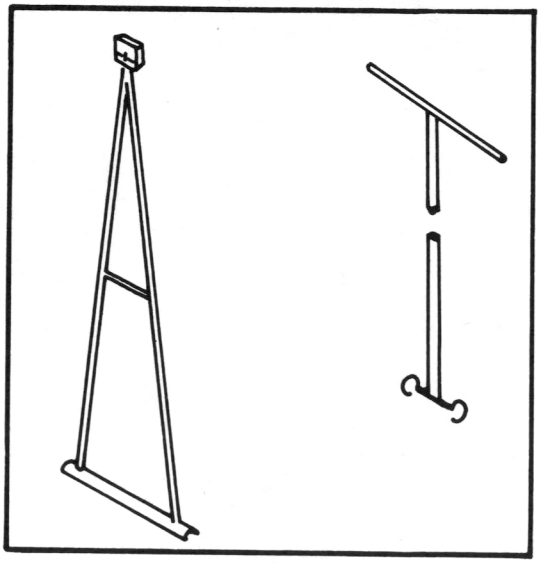
Trailer is used to transport the underground machinery to and from the job site. They may also be used to transport materials to and from the job site during the workday.



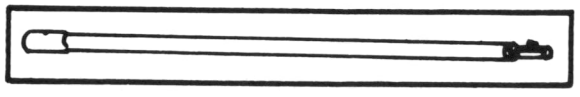
Boring Attachments are auxiliary units which attach to the hydraulic systems or drive line systems of tractors and trenchers. They are used to drive rotating boring steel lengths under streets, driveways, sidewalks and other obstacles.



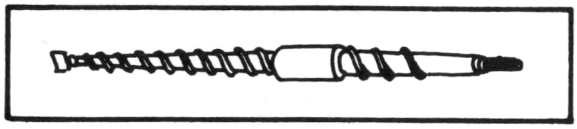
Boring Machines are used as power units to drive boring steel and bits through bores. These are available in walk-behind for small boring jobs to sled mounted for large boring jobs.



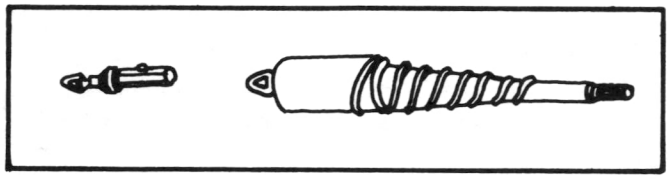
Boring Steel Levels and Guides are used to level and guide boring steel prior and during the boring position.



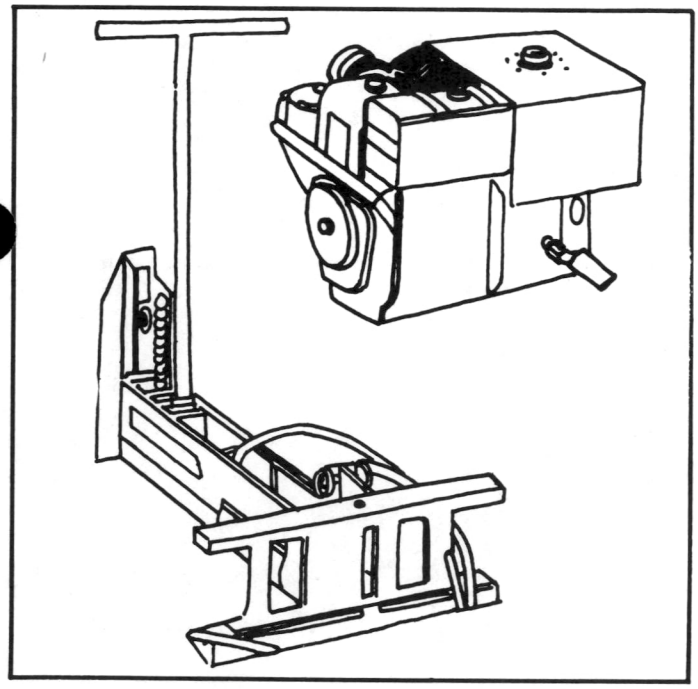
Boring Steel is lengths of steel pipe or rod four (4') foot to ten (10') foot long which screw together adequately for the base length.



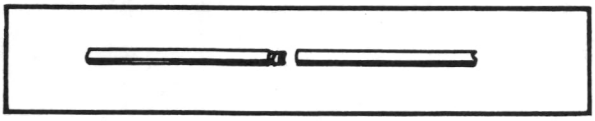
Boring Bits are attached onto the boring steel to cut and compact the material being bored while performing rotation type boring.



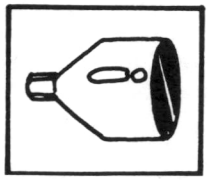
Swivels and reamers are used as attachments to boring steel for increasing the size of the bored hole and for pulling conduit or cable through the bore.



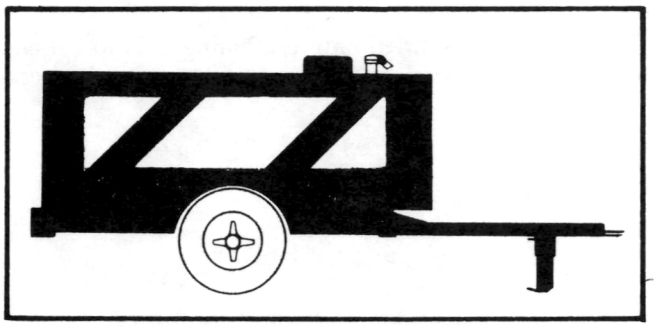
Rod Pushers are used to push steel rods under streets, driveways, sidewalks and other obstacles.



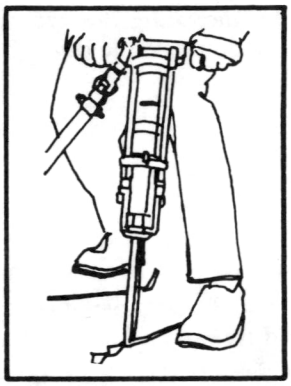
Push Rod is length of steel rod from two (2') to six (6') feet long which screwed together and are pushed by a rod pusher while performing compaction type boring.



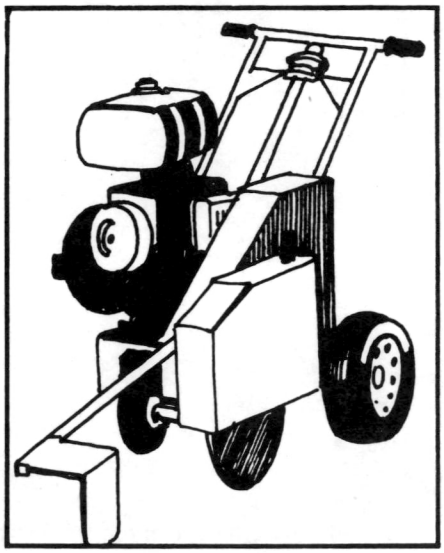
Push Rod reamers and bits are used as attachments to push rod for increasing the size of the bored hole and for pulling conduit or cable through the bore.



Air Compressor is used to provide air pressure for operating all air driven machines.



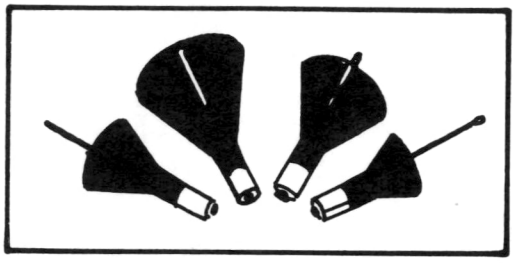
Jack Hammer is used in conjunction with the air compressor or a hydraulic system to break out concrete, asphalt, rock and other hard to remove materials.



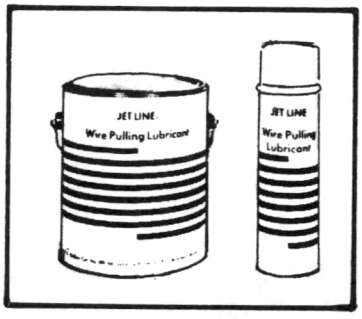
Concrete Saw is used to saw concrete and asphalt when cutting streets, sidewalks, etc.

Underground Blower System is used to blow a pulling line up to ½'' in diameter for distances over 1,000 feet through plastic conduit and ducts. Some units are convertable to vacuum systems.

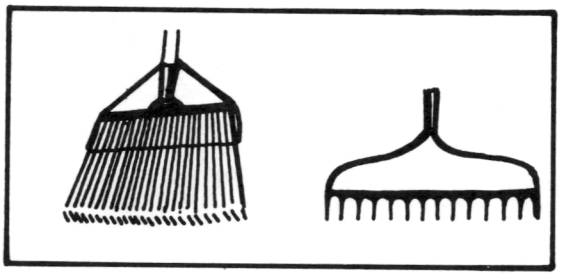
Pulling Line is blown or vacummed through conduit or duct systems and for pulling the cable into the conduit or duct.



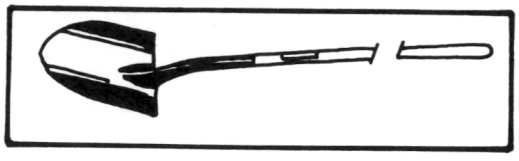
Line Carriers are attached to the pulling line as it is blown or pulled through conduit or duct. They clean out water and dirt as they travel through the conduit or duct.



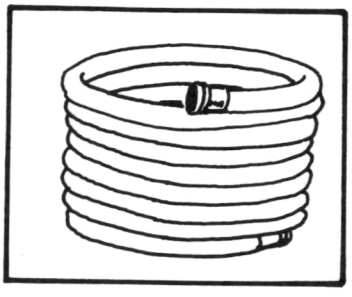
Wire Pulling Lubricant is put on the cable as it is pulled into the conduit or duct to lessen the friction and strain on the cable as it is pulled.



Rakes



Shovel



Hose

Trailer Loading

TRAILER LOADING

After selecting the reels of material to be placed, there are two different reel positions that are considered.
(1) If the material is to be pulled off the reel along easements, over other facilities or into areas not accessable to vehicles (back pull routes) then the reels are turned so that the top end of the material is pointing toward the tongue of the trailer when loaded.
(2) If the material on the reel will roll off directly onto the attachment point, (drive off routes), then the reels are turned so that the top end of the material is pointing toward the back of the trailer when loaded. See Figure 1.

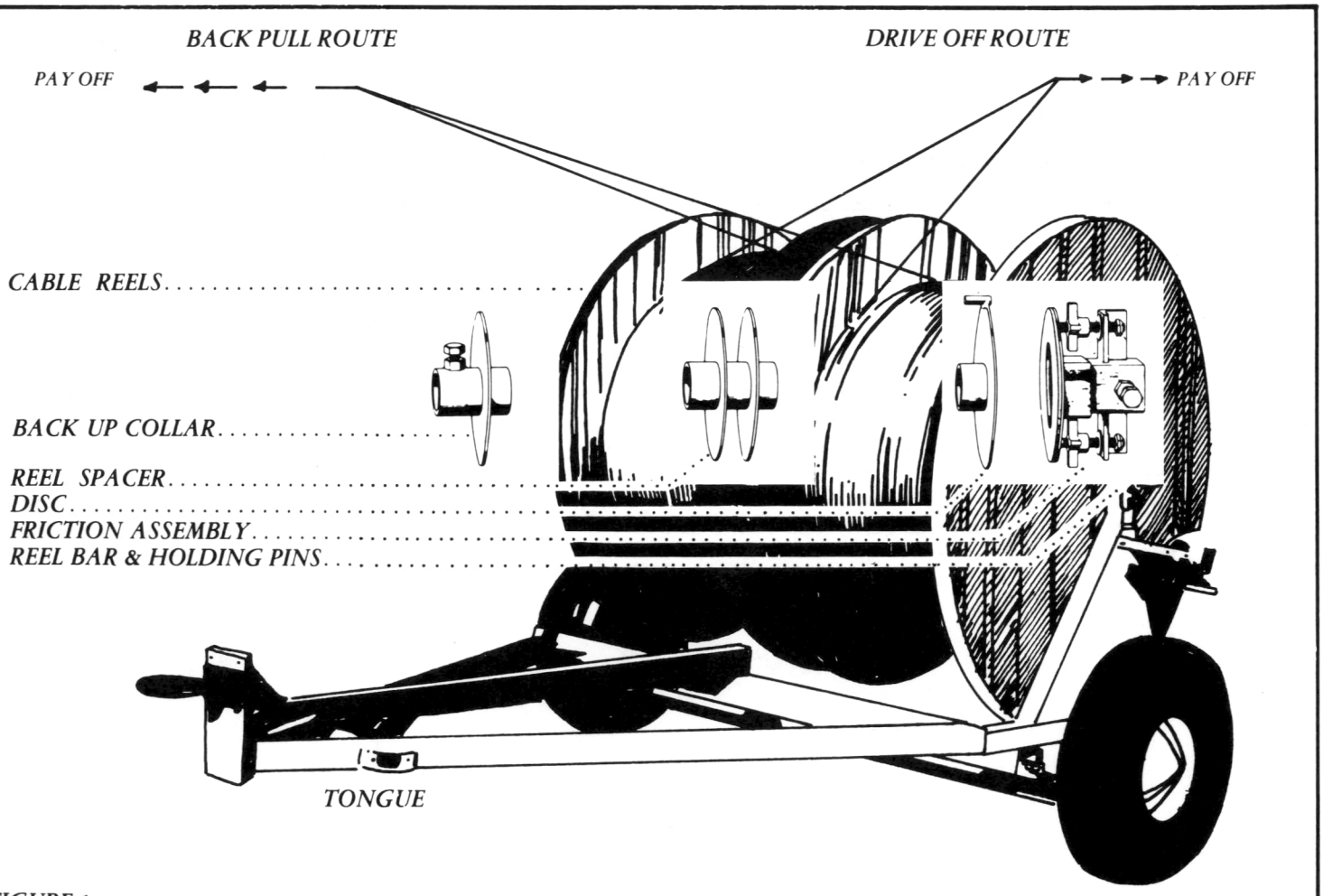


FIGURE 1

NOTE: When loading more than one heavy reel onto the trailer, a between reel support post is required for proper reel support.

After the reels have been positioned according to 1 or 2 above, the reels are then aligned so that the center holes of the reels match. This alignment allows the reel support bar to be pushed through all reels to be loaded. This reel positioning and alignment process also assures that all reels will roll in the same direction as the materials are pulled into place. See Figure 1.

The reel support bar is removed from the trailer and the back up collar of the reel brake is slid onto the bar. The bar is then placed through the center hole of the reel. If more than one reel is to be loaded, a reel spacer is placed between the reels. When the bar is through the last reel to be loaded, install the disc and friction assembly of the reel brake onto the bar. Position the brake assembly securely against the reel sides and tighten the seisure bolts to the reel bar.

The trailer tongue is then lifted and the trailer positioned so that the reel bar fits into the trailer support groove outside the back up collar and outside the friction assembly. The reel bar fastening pins or clamps are secured into place and chock blocks placed under the trailer tires toward the trailer tongue. If only one reel or multiple reels which are light in weight are loaded onto the reel support bar, two crew members can generally pull the trailer tongue down and connect it to the vehicle.

When heavy reels are loaded onto the reel support bar, a chain is connected to the trailer hitch on the vehicle and to the tongue on the trailer. One crew member now stands on each side of the trailer tongue for stabilizing the direction of the tongue. The vehicle is pulled forward slowly. As the vehicle moves forward, it will pull the tongue of the trailer down. When the tongue is almost level with the back of the truck, the crew members place a block under the trailer tongue at the approximate height of the trailer hitch on the vehicle. The vehicle backs up, the chain is removed, and the trailer is connected to the vehicle. Adjust the brake pressure on the friction assembly to prevent free movement of the reels on the reel bar and remove the chock blocks from under the trailer wheels.

The reel(s) is now ready to be transported to the installation site.

NOTE: The protection coverage is left on the cable reels until they arrive at the Installation Site.

PARTIAL REELS

As portions of the material on the reels remain at the end of the work installation route or day, secure the material to the reels as follows:

1. Pull all loose material off the reel and reroll it back onto the reel being sure that the wraps do not cross each other and cap and seal all cable ends.
2. Fasten the material end to the inside flange of the reel securely with a staple to prevent movement on the reel while being transported on the trailer.
3. If the balance of the materials on the partial reels are not used the following day avoid storing them on their sides and avoid storing them where the reel flanges overlap each other. Review the Reel Storage Instruction on page CH-10 of The Cable Handling Section.

Cable Installation Procedures (IM) Cable

CABLE HANDLING AND INSTALLATION PROCEDURES - INTEGRAL MESSENGER (IM)

The installation of integral messenger type coaxial cables is undertaken with caution and attention to maximum sag and tension recommendations. Tensional forces are introduced to IM coaxial cable in a manner quite different from lashed type construction. The effects of construction introduced tensional forces and subsequent low temperature service conditions can be substantially reduced through the use of positive conductor anchoring (captive contact connectors) and proper expansion loops.

There are two different sets of circumstances which prevail when stringing IM cable. There are those routes considered as drive off and those routes considered as back pull.

INSTALLATION PROCEDURES - DRIVE OFF ROUTES - INTEGRAL MESSENGER (IM)

When the tools have been selected, after reviewing the Tool Section, and the cable reels to be placed are loaded onto the trailer according to the Trailer Loading Section instructions, proceed to the installation site.

At the Installation Site, the cable reel covers are removed and the inside reel flanges are carefully inspected to insure that the surface is smooth and free from nails or other imperfections which will damage cable while unreeling.

On drive off routes the cable will pay off the reels directly onto the pole line where it is to be attached. Therefore, follow these procedures:

The trailer is unhooked and appropriate safety equipment is placed along the route. The hardware selected for the project is attached to each pole by the crew members. As the hardware is placed, cable block rods are placed into the suspension clamps and a cable block (roller) is hung onto each rod.

If "J" hook hardware is used, then cable blocks (rollers) are only required at points of stress. After all of the hard ware and cable rollers have been attached to the poles, the crew goes back to the cable trailer and reconnects it to the vehicle. The vehicle and trailer is pulled approximately 50 feet ahead of where the cable is to be attached to the first pole. A crew member then attaches the IM cable support strand or wire to the first pole's hardware.

The vehicle then pulls forward which places tension on the cable. As this occurs, the cable will start to unreel. As the vehicle proceeds to a point approximately 50 ft. ahead of the next pole attachment it stops and backs up to release tension on the cable. With a cable lifting tool, the cable is placed on the cable block of "J" hook previously installed. The vehicle and trailer then proceed to the next pole.

See Figure 1.

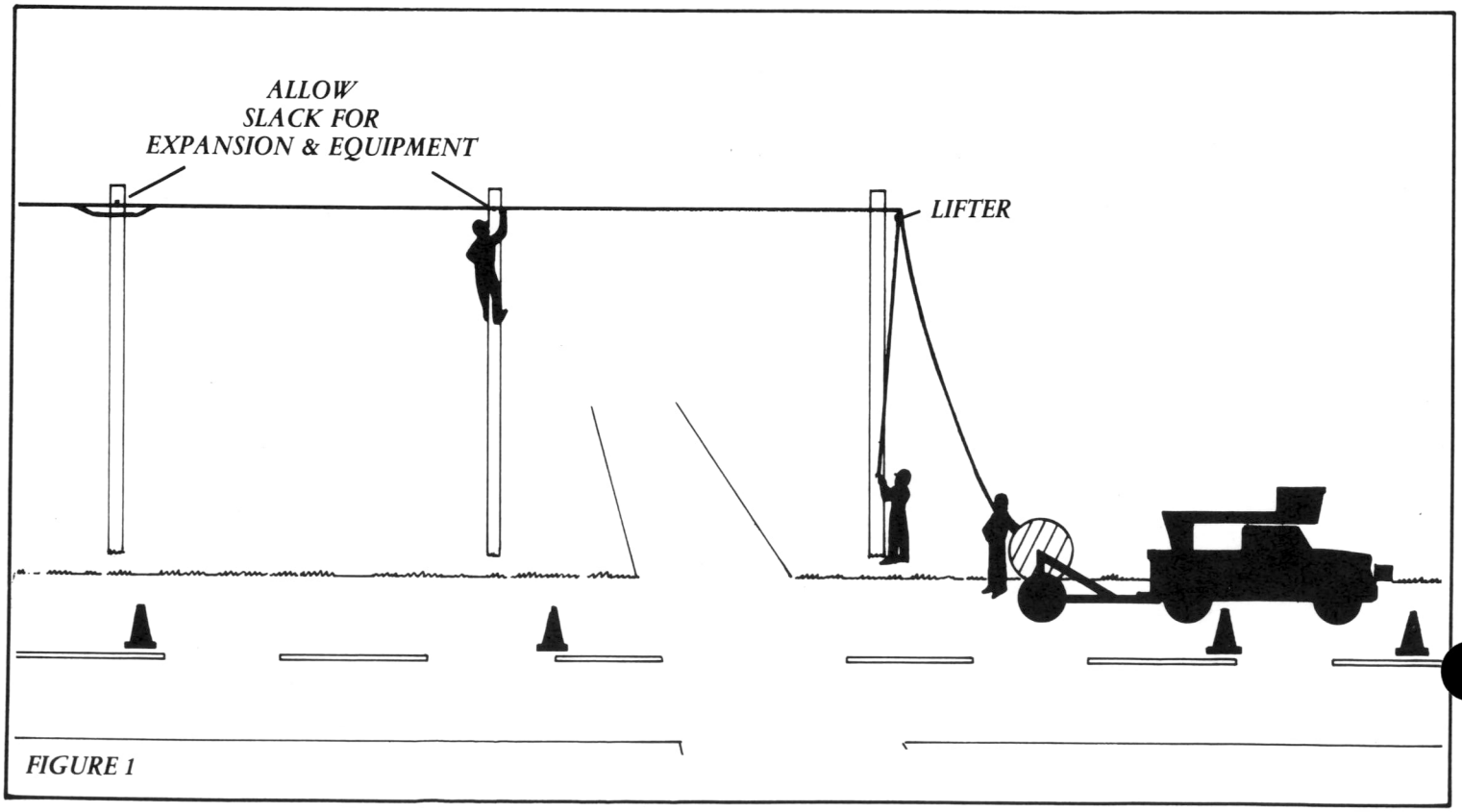


FIGURE 1

As the IM cable crosses intersections where the cable is subject to being hit by passing traffic, the crew members stop and temporarily sag the IM cable, then place and tighten the messenger or wire into the suspension clamp. This holds the cable up clear of the intersection during the balance of the stringing time.

When the cable has been unreeled to the end of the cable run according to instructions given above, the crew should attach a chain hoist and strand grip to the messenger portion of the IM cable and tension it so that all intersections are clear and so that the IM cable is suspended at a safe working height. The crew members then proceed back down the cable run to expansion loop locations and to all locations where equipment is to be spliced into the cable.

Another cable hoist with two strand grips are used to remove a portion of the messenger which will provide slack in the cable for forming expansion loops and extra cable needed to splice the equipment. A grip is placed on each side of the pole where the expansion loop or slack is required and with the hoist the messenger is tensioned until slack occurs. The webbing between the messenger and cable is then cut away between the two grips. A portion of the messenger is removed with bolt cutters. The amount of messenger to be removed is determined from the following messenger removal chart:

SLACK FOR EQUIPMENT - Cut and remove messenger equal to 100% of the desired slack.

EXPANSION LOOPS - Cut and remove messenger equal to 75% of the desired expansion loop depth.

After the appropriate length of messenger has been removed, a messenger splice is installed and tension on the messenger is released.

As portions of the messenger are removed for the expansion loops and/or slack for equipment installation, additional slack from the end of the route position is required. After all expansion loops and slack have been provided, the messenger is permanently attached at the end of the cable run. The crew members proceed back along the entire route, removing the cable blocks and block rods and placing the messenger into the suspension clamps to secure the IM cable in place. Each span is sagged for proper midspan clearance or in accordance with the Book of Tensioning Charts for IM Cable in the back of this section.

At the locations where the cable ends are cut to accommodate equipment, the cable protection caps are placed on the cable ends to protect the cable from the elements. See Figure 2.

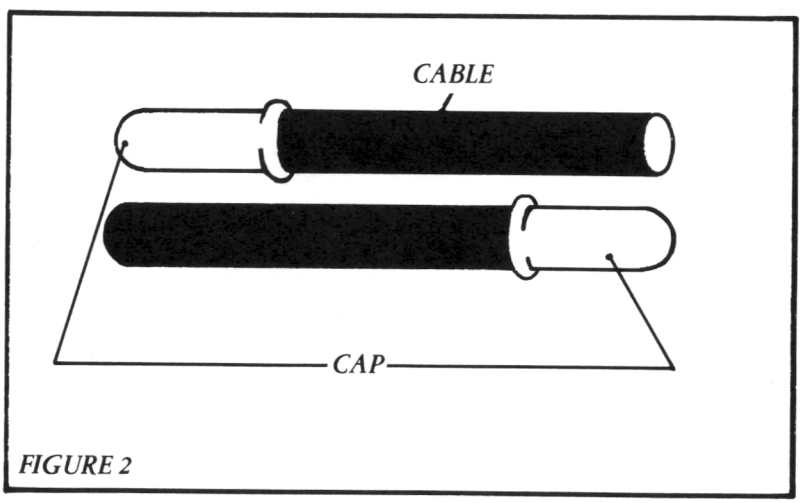


FIGURE 2

INSTALLATION PROCEDURES - BACK PULL ROUTES
INTEGRAL MESSENGER (IM)

When the hardware materials have been selected and loaded and the IM cable to be placed has been loaded onto the trailer according to instructions in the Trailer Loading Section, proceed to the installation site. At the installation site, if the cable must be pulled into position over other existing facilities, backyard easements, or areas which are inaccessible by vehicles, follow these procedures.

Appropriate safety equipment is placed along the route where the IM cable is to be attached to the poles.

The trailer is disconnected from the vehicle approximately 50 feet behind the beginning of the cable run. Hardware is placed on the first pole and the pole chute bracket is installed along with a 45° corner block. Hardware is attached to the poles in the balance of the run and cable block rods and cable blocks (rollers) are installed. Where "J" hook hardware is utilized, cable block rods and cable blocks are only required at points of stress. The crew then returns to the cable trailer location. See Figure 3.

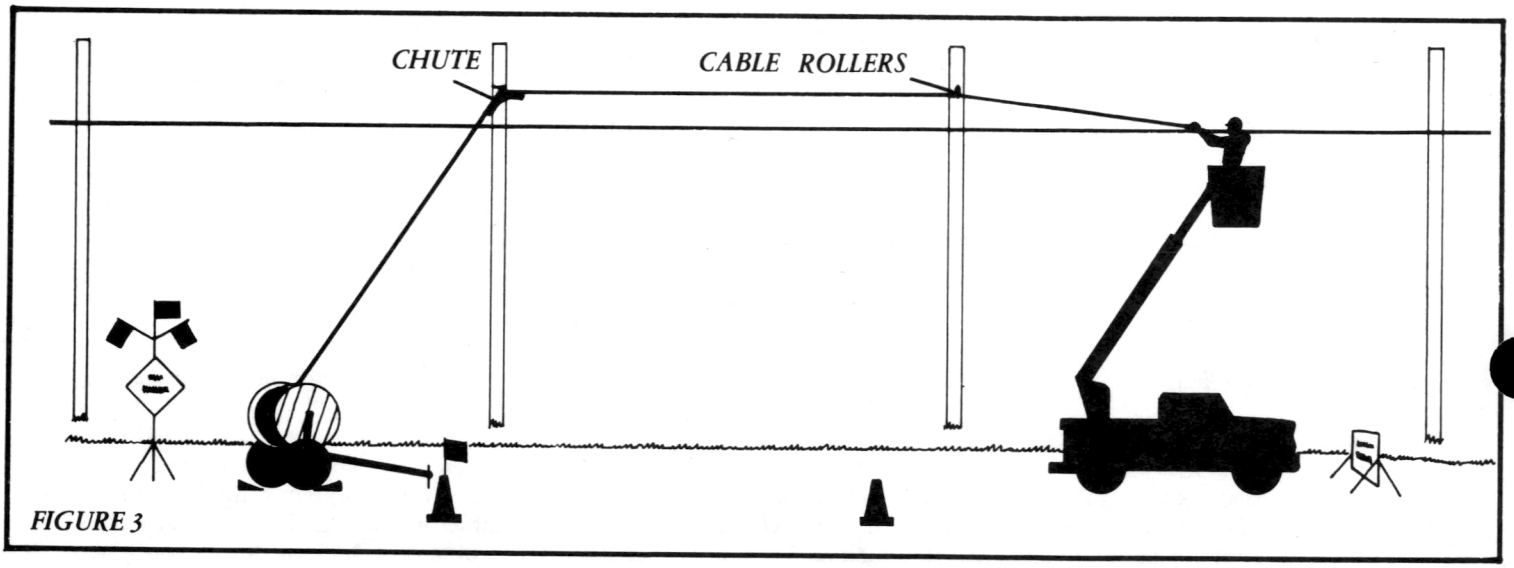


FIGURE 3

A rotating eye pulling grip is placed on the messenger of the reel of IM cable to be pulled into place. A pulling line is attached to the swivel eye pulling grip and the cable is positioned across the cable chute rollers. The pulling line is connected to the vehicle and the IM cable is pulled into place span by span. As the cable passes each pole location, the tension is released and the IM cable is placed over the cable block or "J" hook with the cable lifting tool.

As the IM cable is pulled in at locations where the cable makes turns 10° to 45°, a 45° cable block assembly is installed on the strand or pole. The 90° cable block is utilized at all locations greater than 45 ° and up to 90°. The IM cable should not be pulled around more than one 90° turn. See Figure 4.

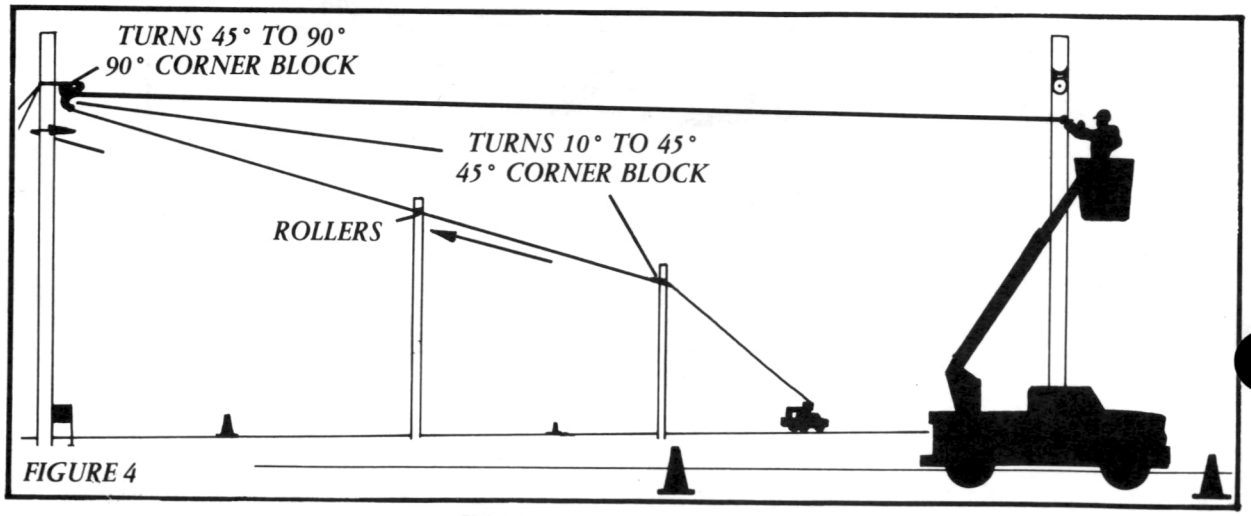


FIGURE 4

As the IM cable crosses intersections, crew members should be posted to watch the cable so that it is not hit by passing traffic. When the IM cable has been strung to the end of the cable run, the crew attaches the IM cable messenger to the dead pole hardware and places the anchor, downguy, ground rod, and band. The crew then returns to the cable trailer location. The crew members now attach a messenger grip to a pulling line. The pulling line is then placed across the rollers of the stationary chute and attached to the messenger approximately 20 ft. from the pole. The IM cable is partially sagged with the pulling line while all excess cable is re-rolled onto the cable reel. A chain hoist and strand grip is attached to the messenger portion of the IM cable and it is tensioned so that all intersections are clear and so that the IM cable is suspended at a safe working height. The crew now proceeds back down the cable run to expansion loop locations or locations where equipment is to be spliced into the cable. The procedures for providing expansion loops and slack for splicing in equipment described on page IM-13 of this section are then followed.

INSTALLATION PROCEDURES - BACK PULL - WINCH INTEGRAL MESSENGER CABLE (IM)

If conditions dictate that the length of the route being pulled requires the use of the winch, the following procedures are followed:

The trailer is disconnected from the truck approximately 50 ft. behind the beginning of the cable run. The hardware, anchor, downguy and bond is placed on the first pole and the pole chute bracket is installed along with a 45° corner block. Additional hardware is attached to the poles in the balance of the route along with cable blocks (rollers) and cable block rods. All 45° and 90° cable blocks (rollers) are also installed.

From the anticipated end of the run, the winch is set up and adjusted toward the cable run. The winch cable is then strung along the cable run and placed over all of the cable blocks (rollers) at all non-stress locations. The winch line should run across steel winch line blocks (rollers) at all corners and other points of stress to avoid damage to the rubber or plastic rollers that are used in the cable roller blocks.

After the winch line has been connected to the rotating "eye" pulling grip which is attached to the messenger of the IM cable, and after the cable has been placed across the rollers of the stationary chute, the winch operator tensions the winch line. The reel brake on the cable trailer is adjusted so that the pulling tension of the cable does not exceed recommended pulling tension per individual cable specifications.

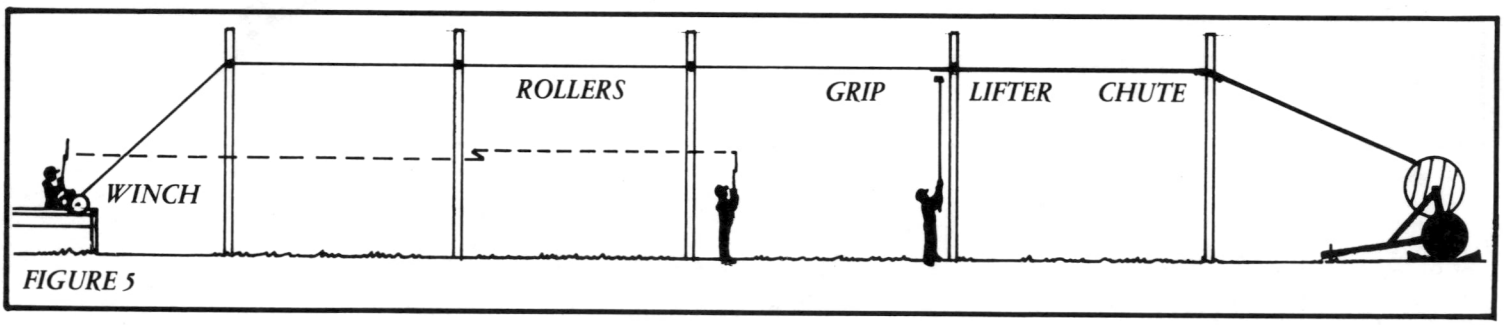


FIGURE 5

A dynamometer is utilized on all long cable pulls or where the tension on the cable might exeed the specifications. The cable is pulled into place with the winch, span by span, to the point where the cable run ends. As the cable passes the pole locations where the winch line is running across the steel winch line blocks, tension on the winch line is reduced slightly and the coax is placed in the rolling blocks. See Figure 5.

There should be adequate personnel in communication with the winch operator to watch the cable as it is being pulled into place. When the winch has pulled the IM cable to the end of the cable run, the IM cable slack and expansion loops are cut into poles the same as described per the instructions on page IM-13.

INSTALLATION PROCEDURES - EXPANSION LOOP

To allow for maximum temperature extremes, expansion loops are placed at each pole and at the input and output of all equipment. For locations where maximum temperature variations are not anticipated, users may modify the number and placement of loops based on their evaluations of installations in similar locations and under similar conditions.

In all cases, expansion loops should always be formed with a tool designed for the purpose and never by hand. See Figure 6

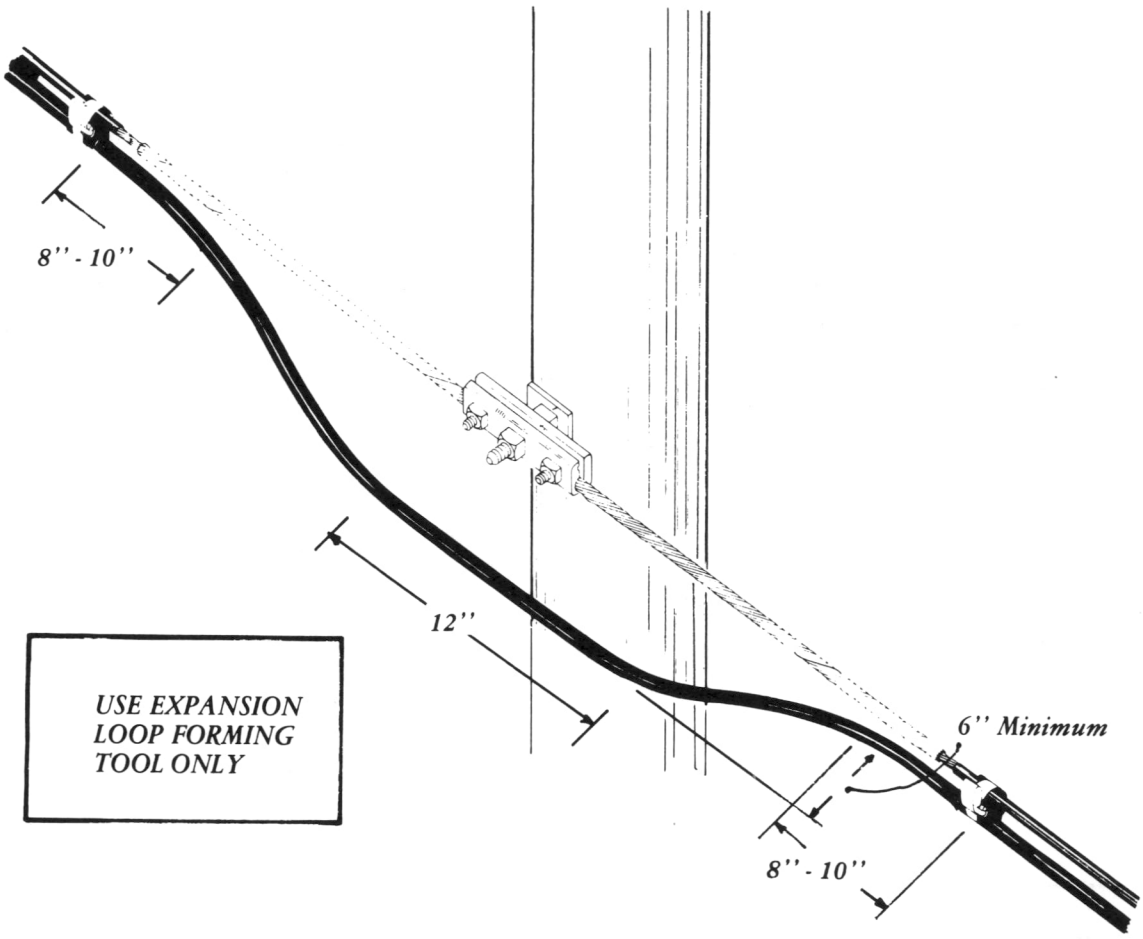


FIGURE 6

INSTALLATION PROCEDURES - MULTIPLE CABLES

In locations where more than one cable is required, there are two procedures which should be followed:

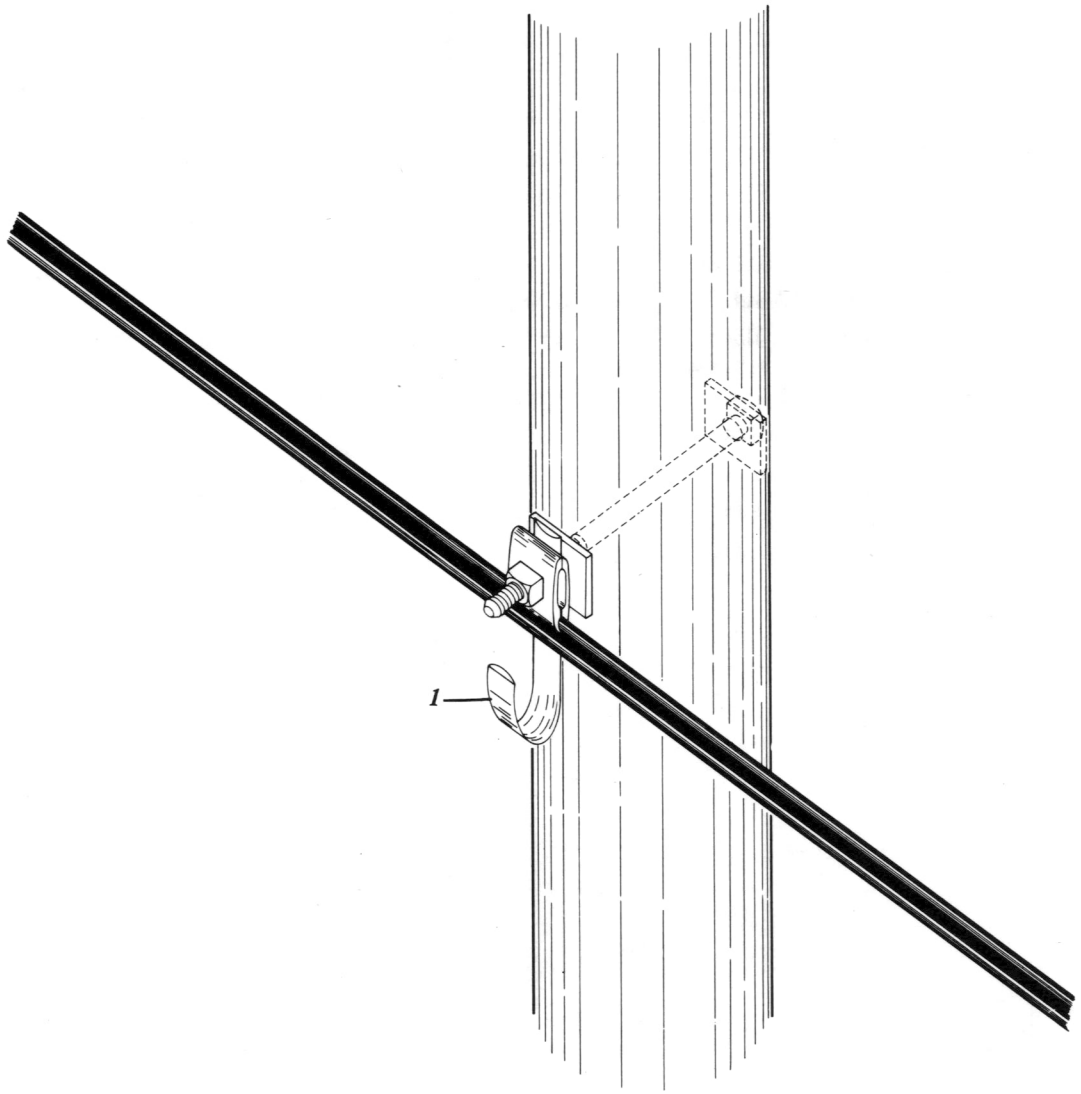
(1) After the IM cable installation has been completed, additional cables may be lashed to it. The number and sizes of cables that the IM cable can accommodate is determined by the size of the messenger strand of wire used when the IM cable is manufactured.

(2) Do not install IM cables in the areas requiring multiple cables. Instead, place separate messenger strand or wire then lash the multiple cables required to the separate messenger.

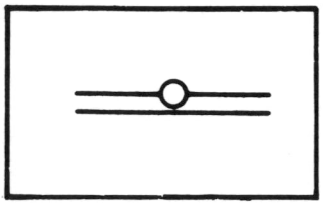
After selecting the method to be used for placement of the multiple cables, the instructions contained in the "CABLE HANDLING AND INSTALLATION PROCEDURES - LASHED CABLE" is followed.

CABLE HANDLING AND INSTALLATION PROCEDURES
INTEGRAL MESSENGER IM
POLE FRAMING ILLUSTRATIONS

FIGURE IM-1 CABLE PLACING-STRAIGHT LINE IM-56
FIGURE IM-2 CABLE PLACING-STRAIGHT LINE—
STEEL OR CONCRETE POLE IM-57
FIGURE IM-3 CABLE PLACING-ANGLE POLE IM-58
FIGURE IM-4 CABLE PLACING - STRAIGHT LINE
POLE CROSS-OVER IM-59
FIGURE IM-5 CABLE PLACING-MID-SPAN CROSS-OVER IM-60
FIGURE IM-6 CABLE PLACING-FALSE DEAD-END IM-61
FIGURE IM-7 CABLE PLACING-LINE POLE DEAD-END
COMBINATION No. 1 ..... IM-62
FIGURE IM-8 CABLE PLACING-LINE POLE DEAD-END
COMBINATION No. 2 ..... IM-63
FIGURE IM-9 CABLE PLACING-DEAD-END IM-64
FIGURE IM-10 CABLE PLACING-DOUBLE DEAD-END IM-65
FIGURE IM-11 HARDWARE IM-66

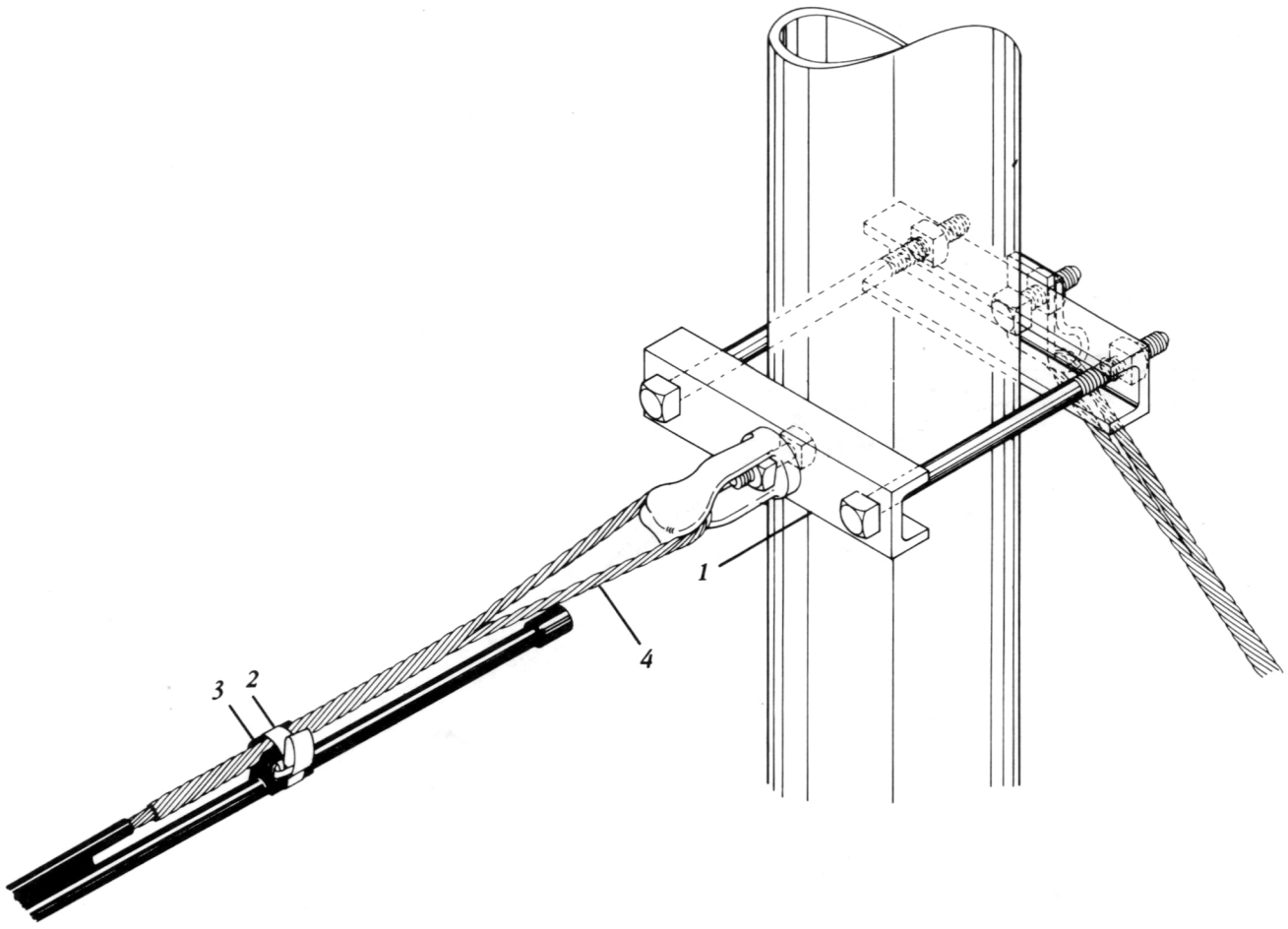


Map Legend



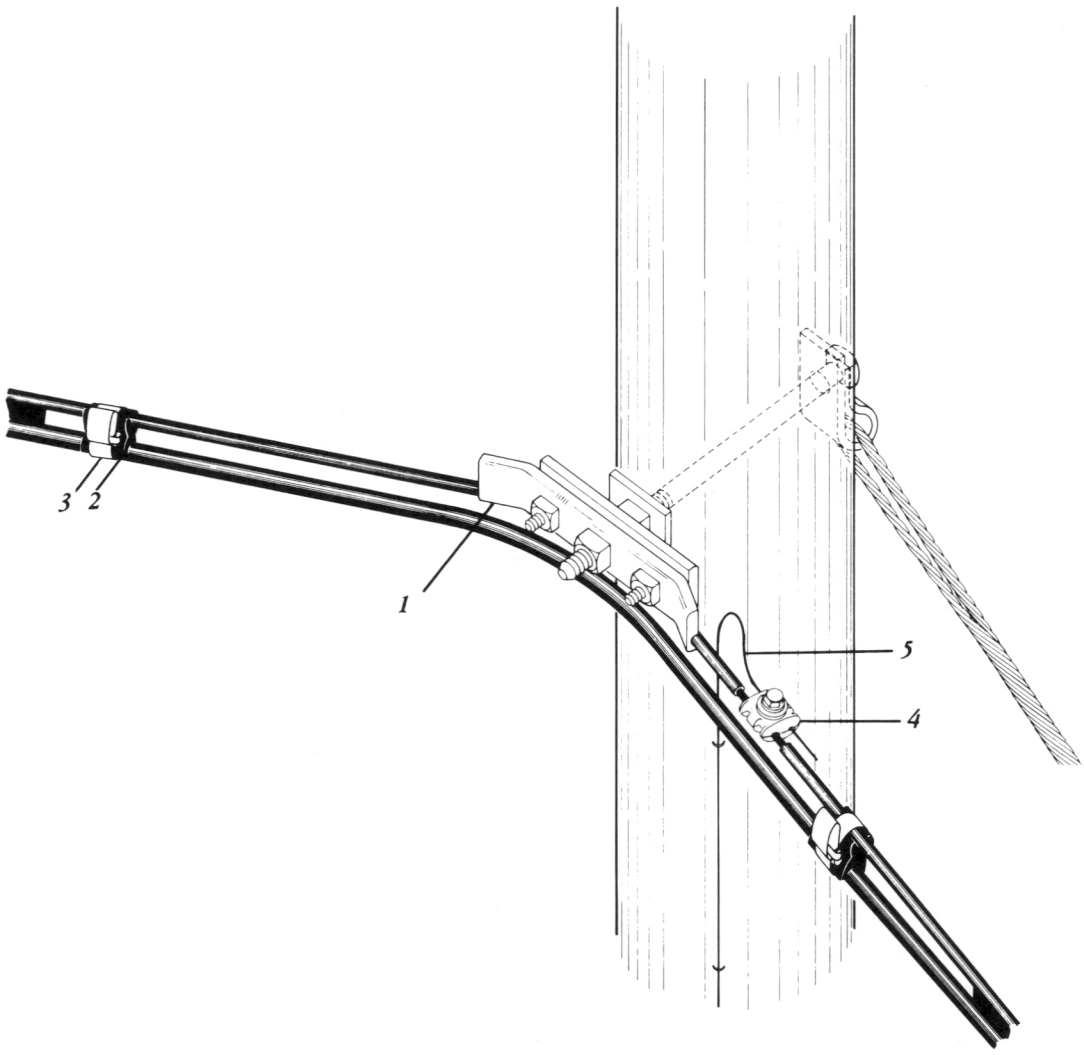
Item	*Description*
1	*J Hook Clamp Hardware*

FIGURE IM-1 IM CABLE PLACING - STRAIGHT LINE

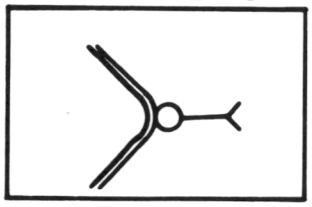


Item	Description
1	Dead End Clamp Bracket
2	Cable Spacer
3	Strap (Steel or concrete pole)
4	Dead End Clamp

FIGURE IM-2 IM CABLE PLACING - DEAD END

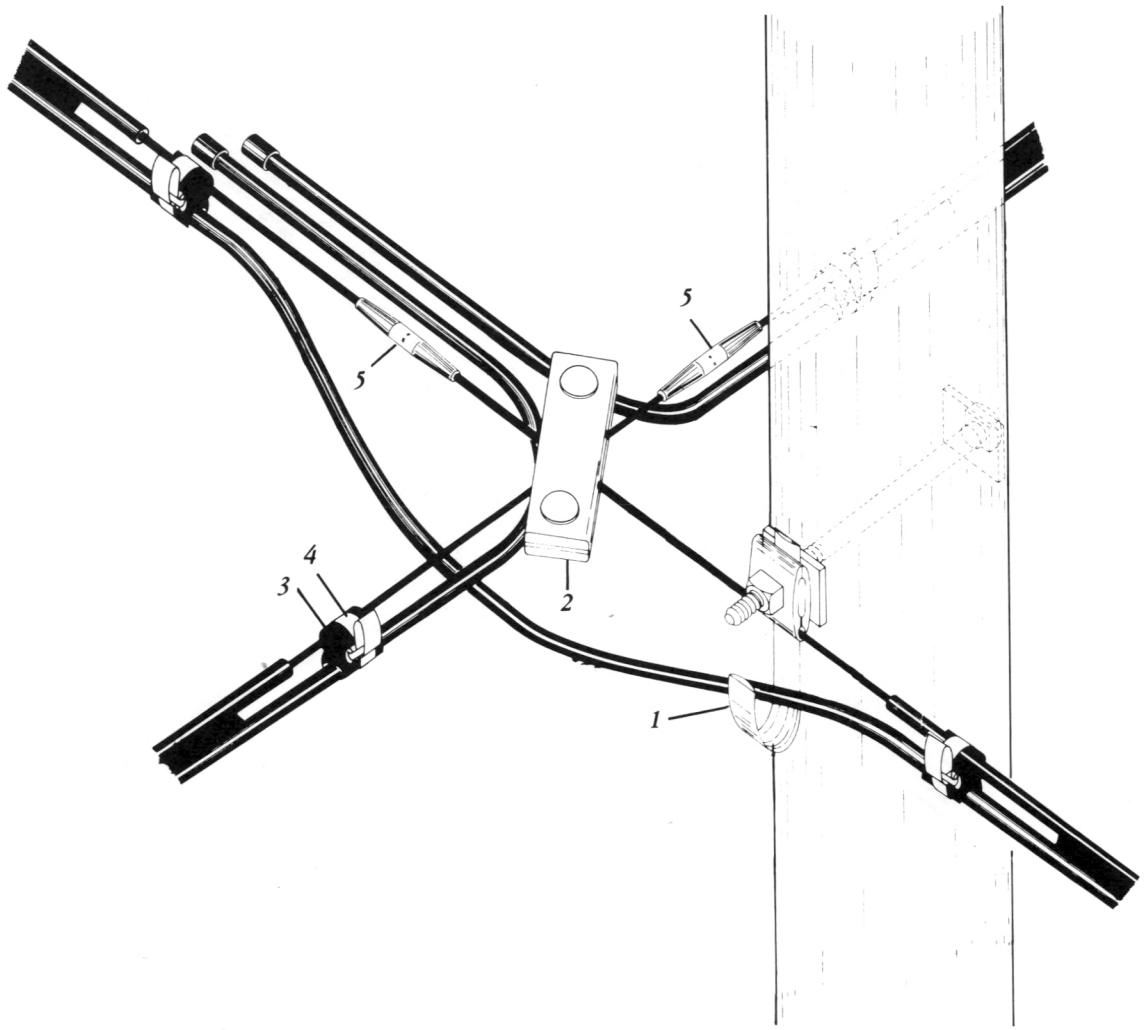


Map Legend



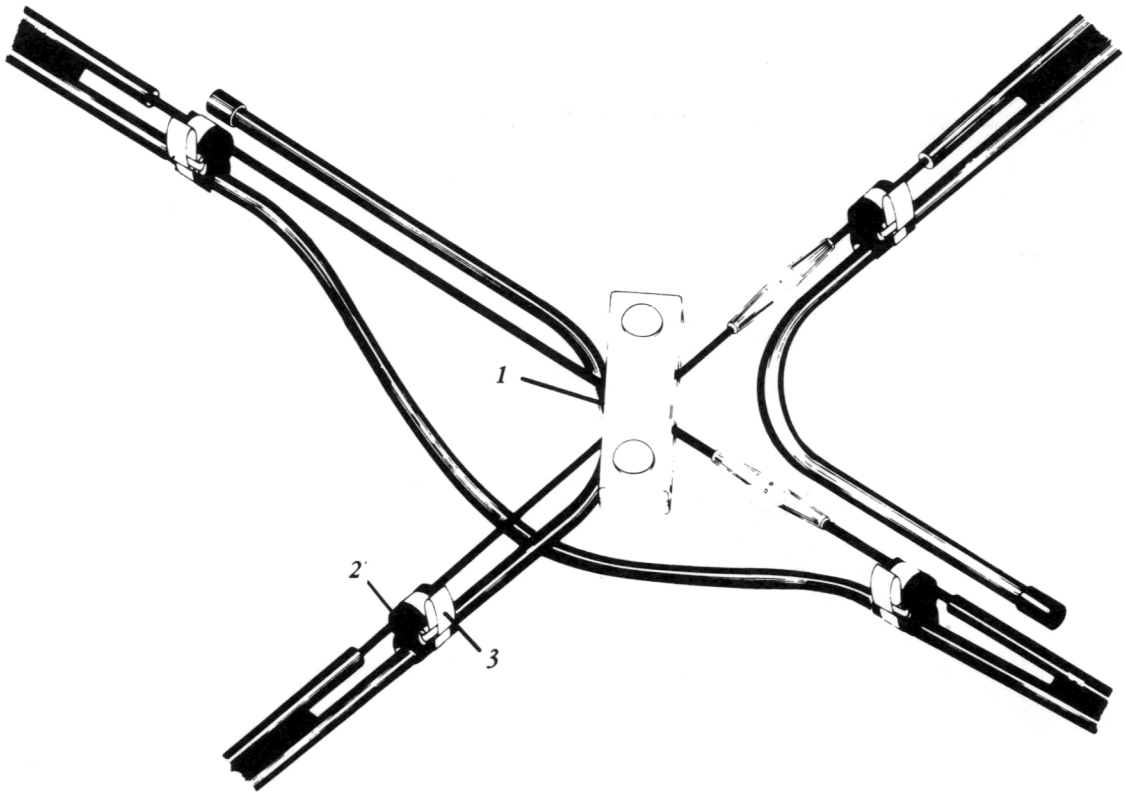
Item	*Description*
1	*3 Bolt Curve Clamp Hardware*
2	*Cable Spacer*
3	*Cable - Support Strap*
4	*Bonding Clamp*
5	*Ground Wire*

FIGURE IM-3 CABLE PLACING - ANGLE POLE



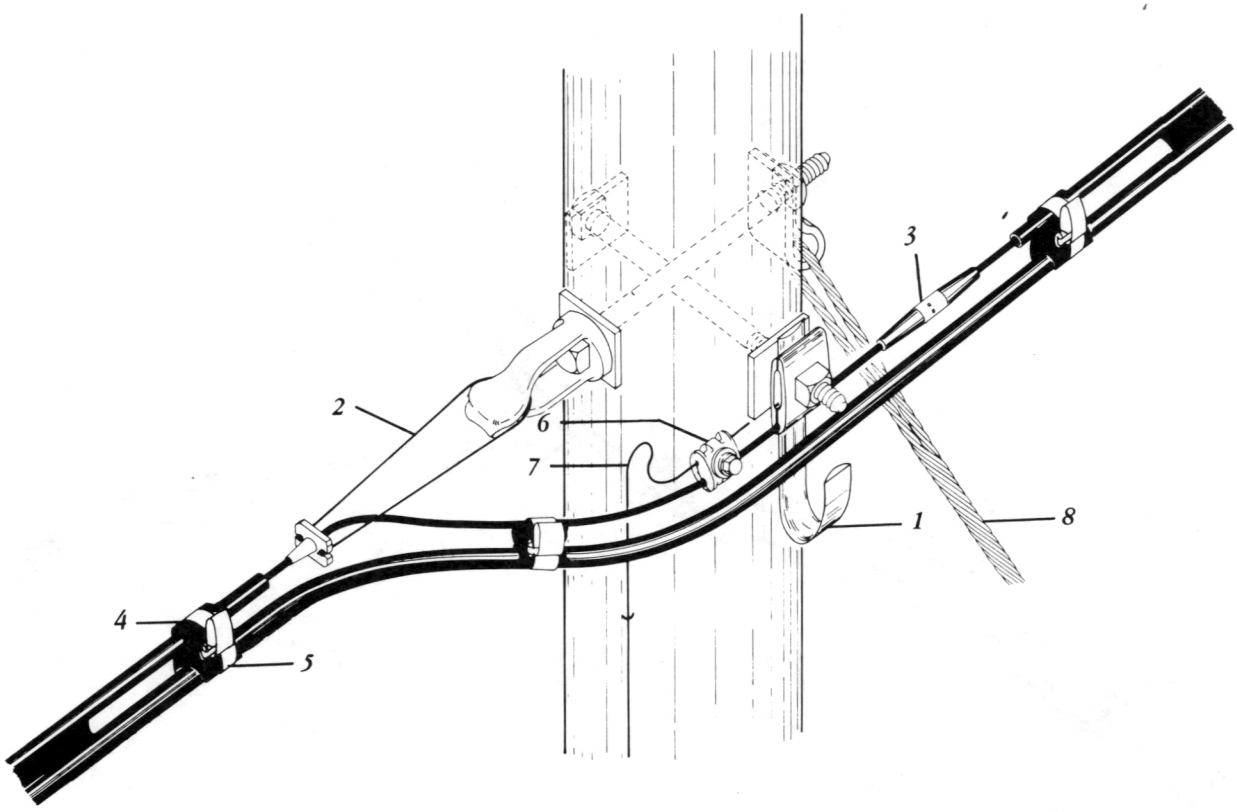
Item	Description
1	"J" Hook
2	Cross-Over Clamp
3	Cable Spacer
4	Cable Support Strap
5	Messenger Splice

FIGURE IM-4 CABLE PLACING - STRAIGHT LINE POLE CROSS-OVER

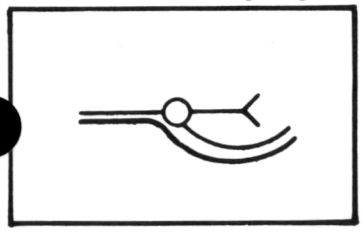


Item	*Description*
1	*Crossover Clamp Hardware*
2	*Cable Spacer*
3	*Cable Support Strap*

FIGURE IM-5 CABLE PLACING - MID-SPAN CROSS-OVER

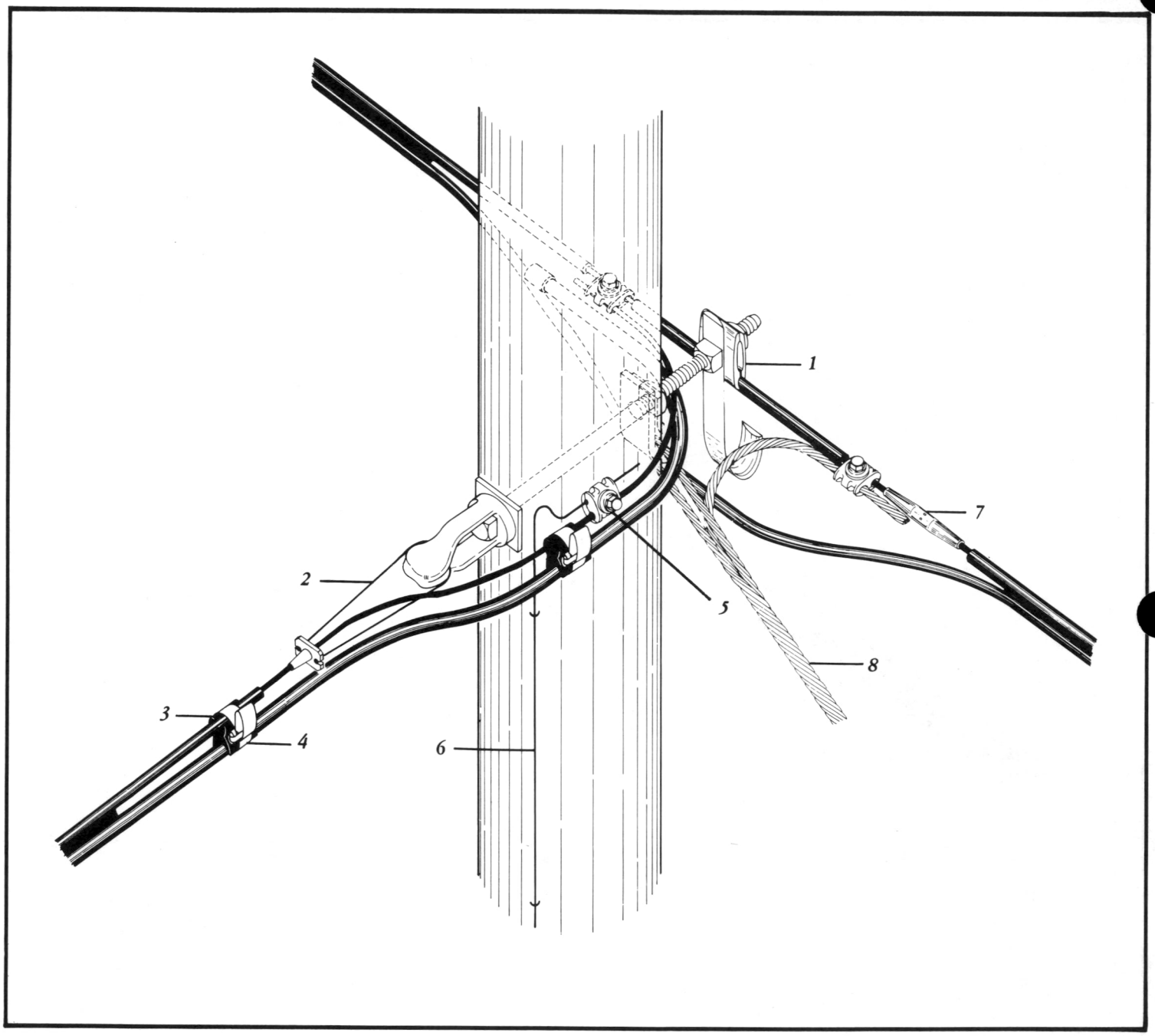


Map Legend



Item	*Description*
1	*J Hook Clamp - Dead End Hardware*
2	*Messenger Dead End*
3	*Messenger Splice*
4	*Cable Spacer*
5	*Cable Support Strap*
6	*Bonding Clamp*
7	*Ground Wire*
8	*Down Guy*

FIGURE IM-6 CABLE PLACING - FALSE DEAD-END



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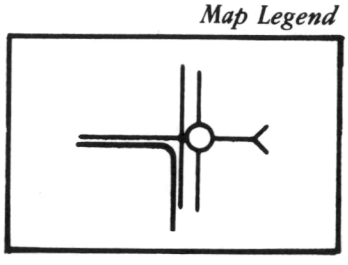
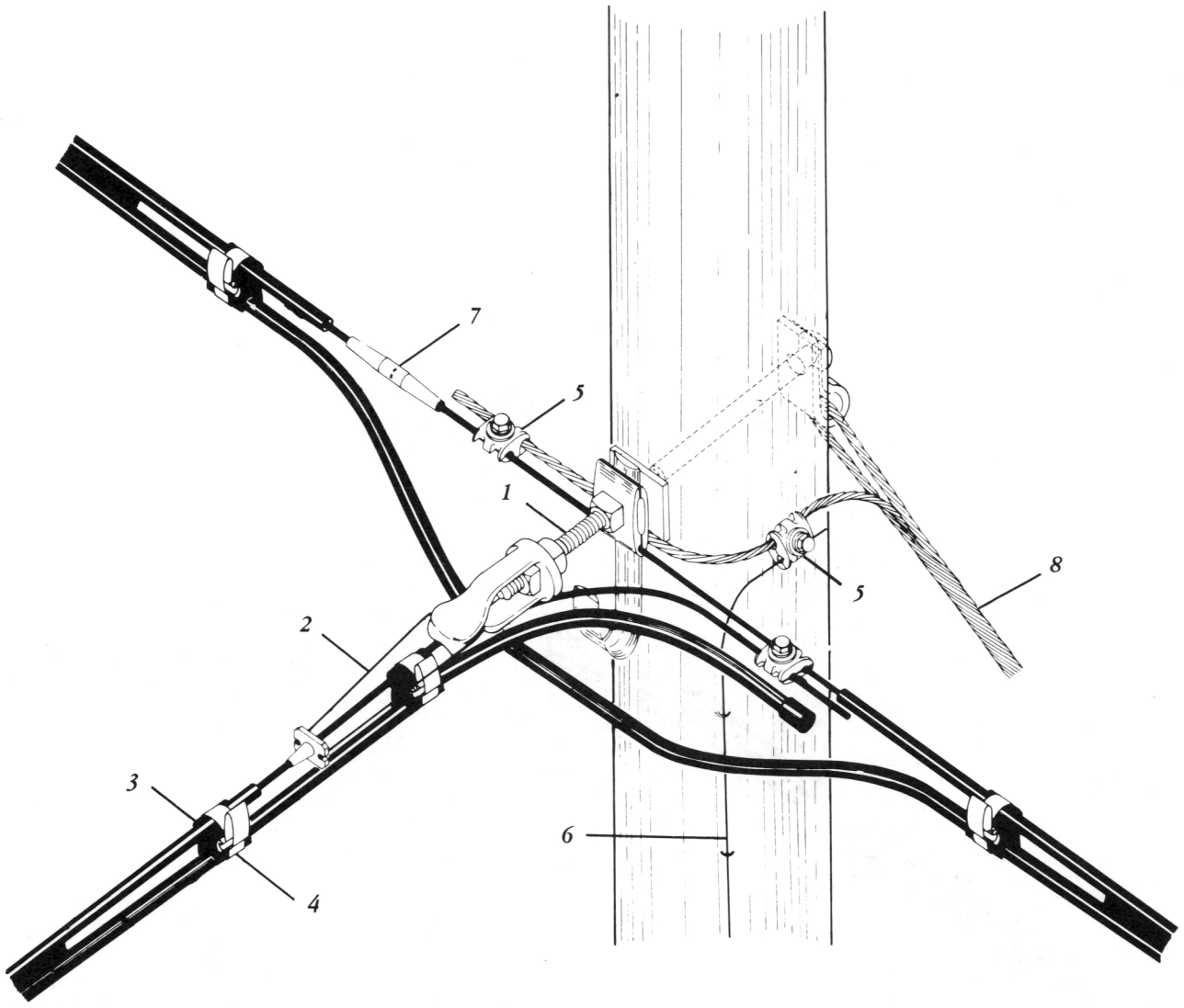


Item	*Description*
1	*J Hook Clamp - Dead End Hardware*
2	*Messenger Dead End*
3	*Cable Spacer*
4	*Cable Support Strap*
5	*Bonding Clamp*
6	*Ground Wire*
7	*Messenger Splice*
8	*Down Guy*

FIGURE IM-7 CABLE PLACING - LINE POLE DEAD-END COMBINATION No. 1



Item	Description
1	J Hook Clamp
2	Messenger Dead End
3	Cable Spacer
4	Cable Support Strap
5	Bonding Clamp
6	Ground Wire
7	Messenger Splice
8	Down Guy

Map Legend

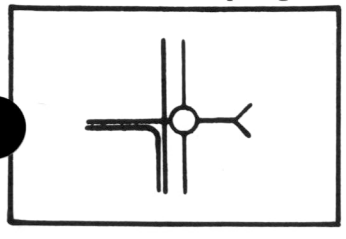
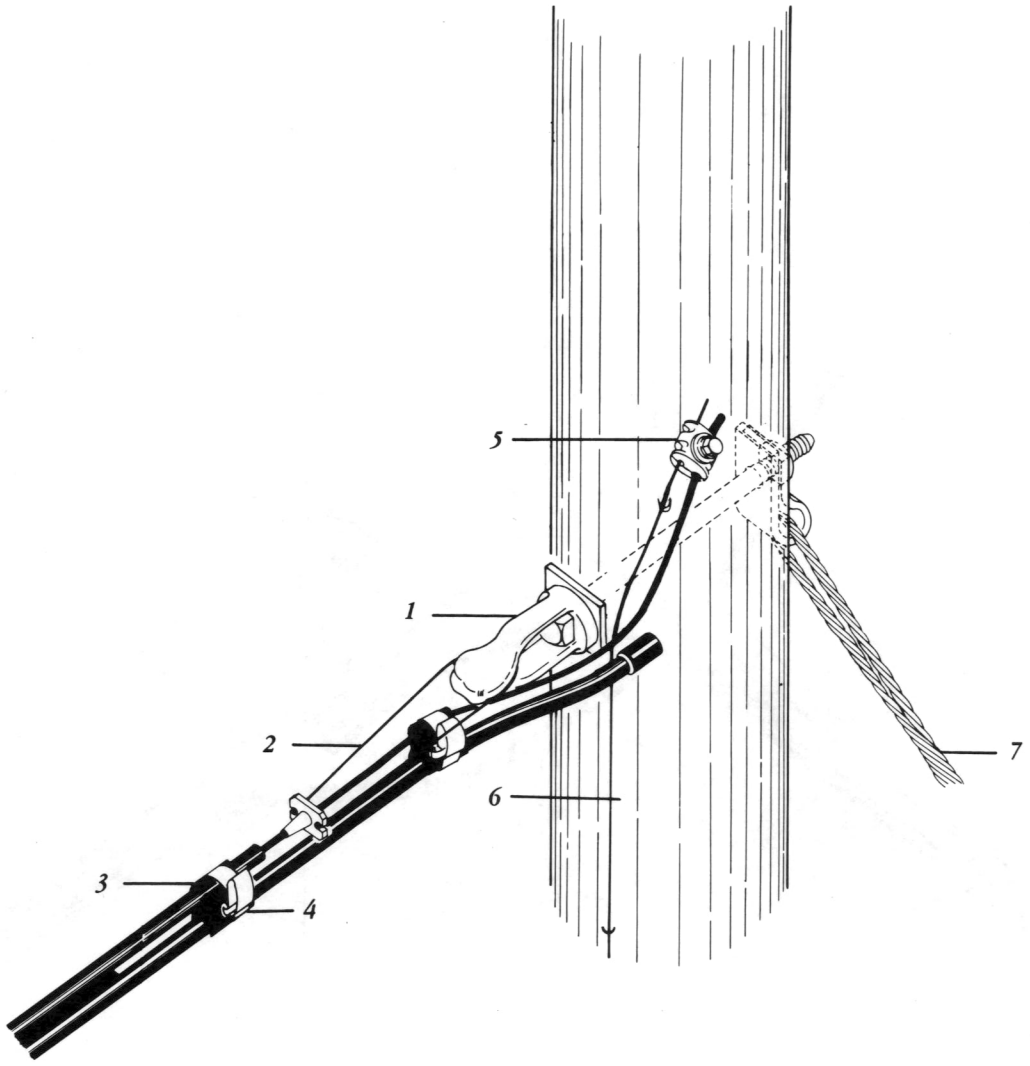
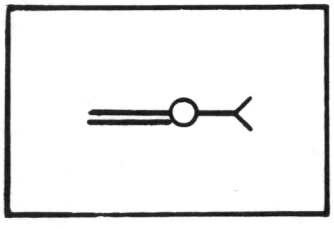


FIGURE IM-8 CABLE PLACING - LINE POLE DEAD-END COMBINATIONS No. 2

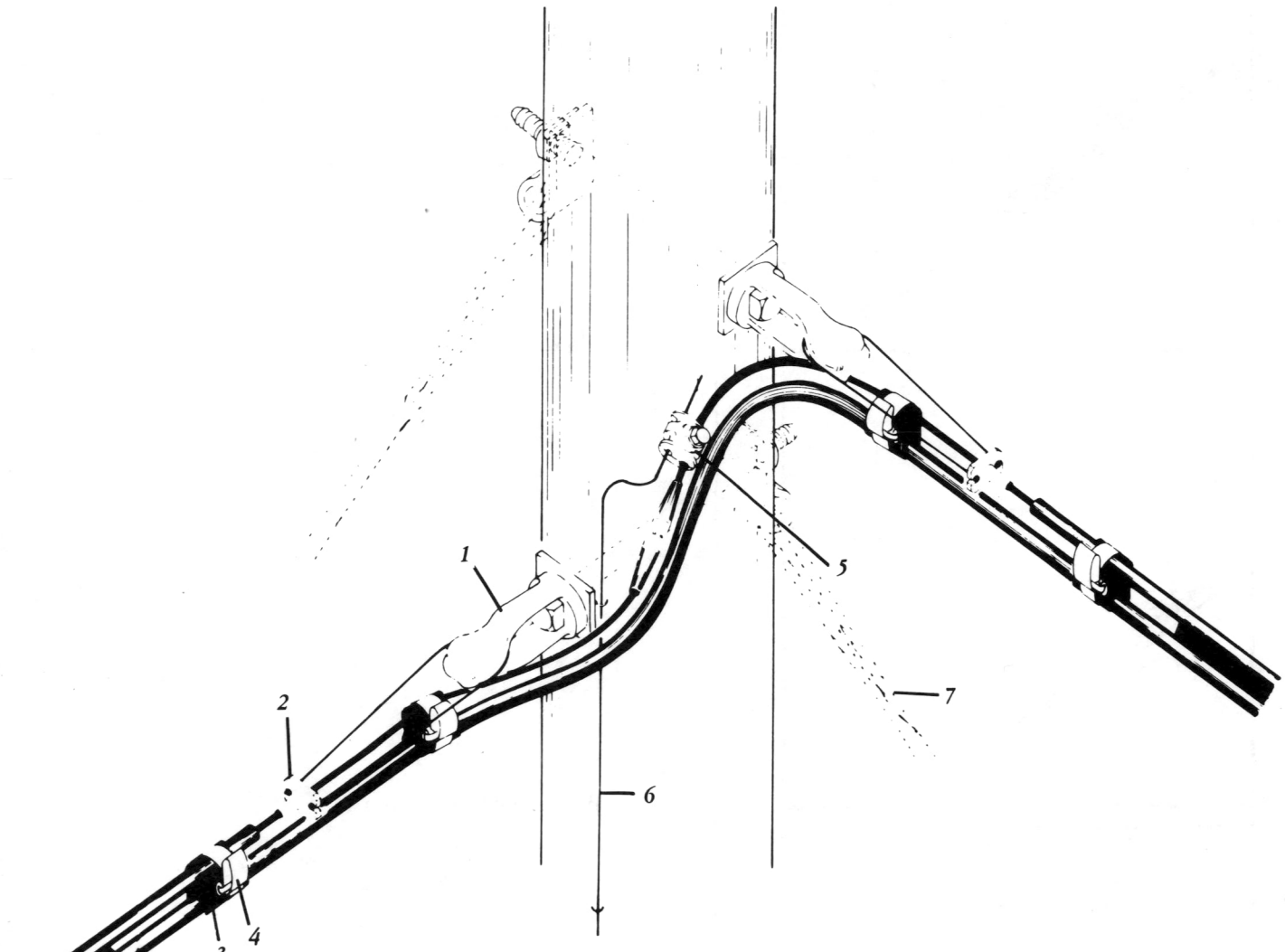


Map Legend



Item	*Description*
1	*Dead-End Hardware*
2	*Messenger Dead End*
3	*Cable Spacer*
4	*Cable Support Strap*
5	*Bonding Clamp*
6	*Ground Wire*
7	*Down Guy*

FIGURE IM-9 CABLE PLACING - DEAD-END

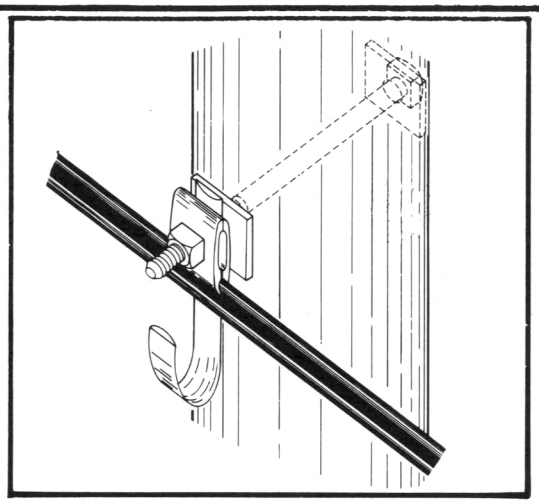


Item	*Description*
1	*Double Dead-End Hardware*
2	*Messenger Dead End*
3	*Cable Spacer*
4	*Cable Support Strap*
5	*Bonding Clamp*
6	*Ground Wire*
7	*Down Guy*

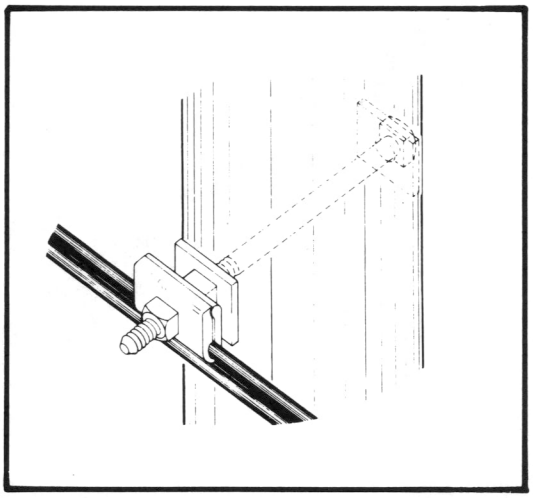
FIGURE IM-10 CABLE PLACING - DOUBLE DEAD-END

INTEGRAL MESSENGER (IM) HARDWARE

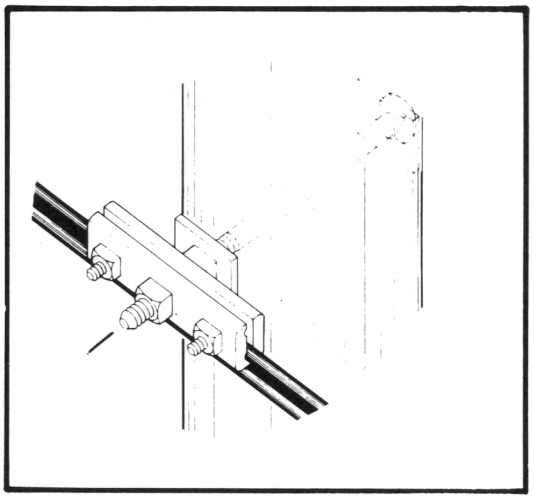
There are three basic sets of hardware generally used to support integral messenger (IM) cables. They are as follows:



1. J. Hook with Suspension Clamp



2. 1 Bolt Suspension Clamp



3. Three (3) Bolt Suspension Clamp

FIGURE 11

The hardware selected is determined by the sizes and weight of integral messenger cables to be installed.

Cable Handling and Installation Procedures Lashed Cable

CABLE HANDLING AND INSTALLATION PROCEDURES
DRIVE OFF ROUTES - LASHED CABLE

When the tools have been selected, after reviewing the Tool Section, and the cable reels to be placed have been loaded onto the trailer according to the Trailer Loading Section instructions, proceed to the installation site.

At the installation site, on routes where the cable will pay off the reels directly into the pole line, use the following installation procedures. See Figure 1.

While appropriate safety equipment is placed along the route where the cable is to be attached to the strand, a crew member removes the cable reel covers and inspects the inside reel flanges to ensure that the surfaces are smooth and free from nails or other imperfections which will damage the cable while unreeling.

Pushers, positioners and guides are placed on the strand by a crew member at the first pole in the route. The vehicle and reel trailer is moved approximately 50 feet down the route from this pole and the cable is unreeled and fed through the guide, positioner and lashing machine to the pole. The lashing wire is placed around the tension rollers on the lasher and attached to the lashing wire clamp. Pull ropes are attached to the guides, positioners and lasher and attached to the vehicle.

While a crew member holds the cable(s) at the pole, the vehicle moves slowly forward pulling the lasher and accessories along the strand. The lashing machine wraps lashing wire around the cable and strand which attaches them together. See Figure 1.

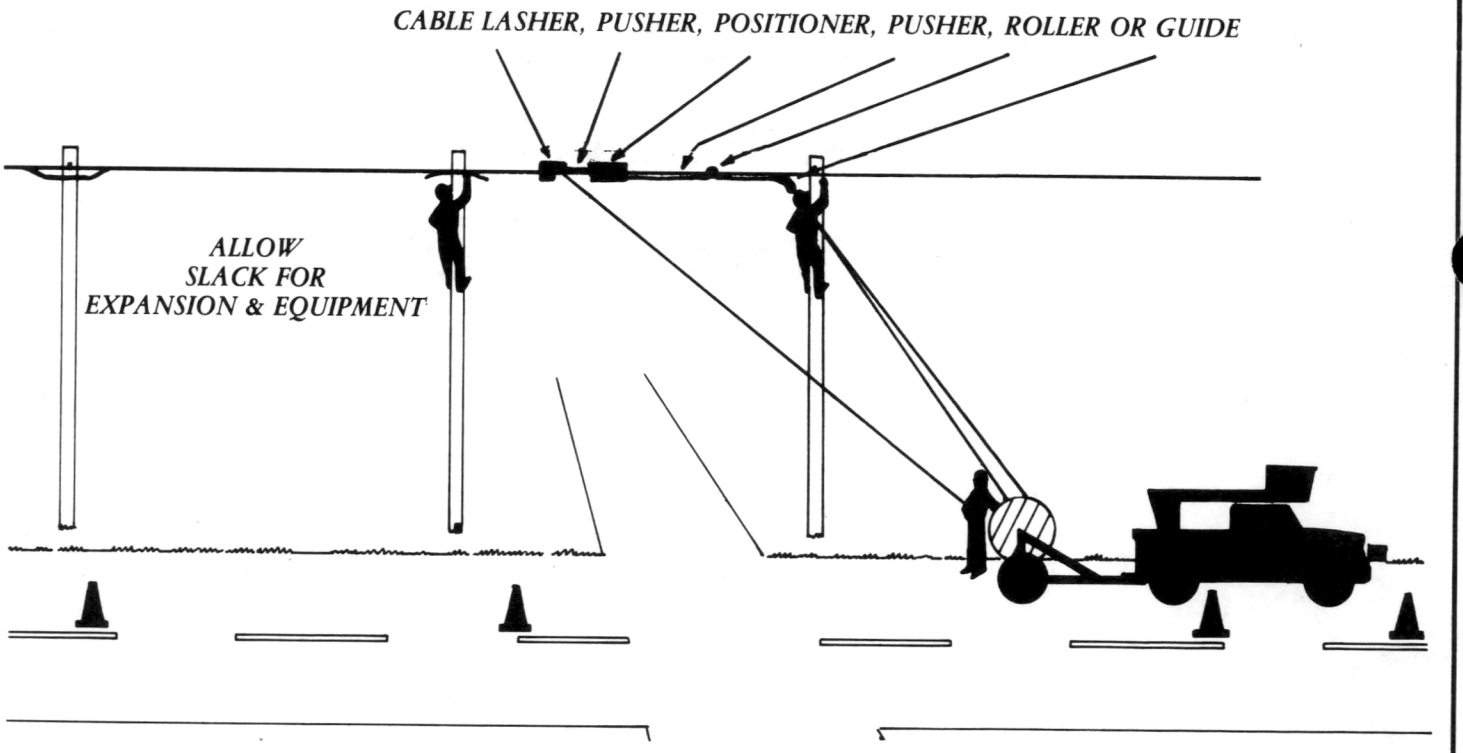


FIGURE 1

The cable reel trailer and truck is always approximately 50 feet ahead of the location where the cables are being fed into the guide on rollers. The tension on the cable should be such that the cable flows easily through the cable guide and/or rollers. Determine from individual cable specification sheets the maximum recommended pulling tension.

When the lasher and accessories reach the next pole in the route, the vehicle and reel trailer stops. A crew member temporarily clamps the lashing wire to the strand and transfers the lasher and accessories to the other side of the pole, the crew member uses an expansion loop tool to form an expansion loop in the cable, then attaches the lashing wire out of the lasher to a lashing wire clamp, then holds the cable while the vehicle and reel trailer moves slowly forward lashing the next span of cable to the strand. The crew member then releases the cable, makes the temporary lashing wire clamp permanent and installs the cable spacers and aerial cable support straps. The crew member then moves to the next pole and repeats this work function.

This process continues until the entire cable route has been lashed.

At all locations where the cable ends are cut to accommodate equipment, the cable protective caps are placed on the cable ends to protect the cable from the elements. See Figure 2.

Each additional drive-off cable route is completed according to the procedures given above.

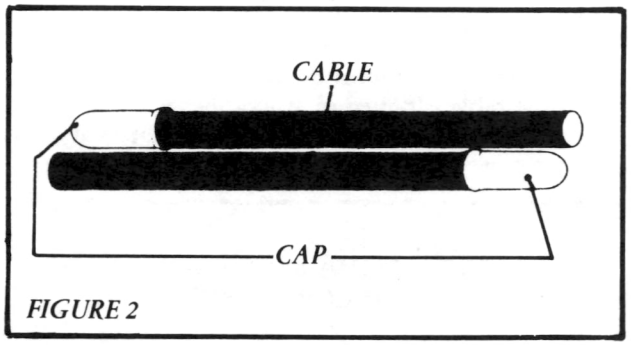


FIGURE 2

INSTALLATION PROCEDURES - BACK PULL ROUTE - LASHED CABLE

When the tools have been selected, after reviewing the Tool Section, and the cable reels to be placed have been loaded onto the trailer according to the Trailer Loading Section instructions, proceed to the installation site.

At the installation site, where the cable route is back pull, or where the cable(s) must be pulled into position over other existing facilities, backyard easements, or areas which are inaccessible by vehicles, follow these procedures:

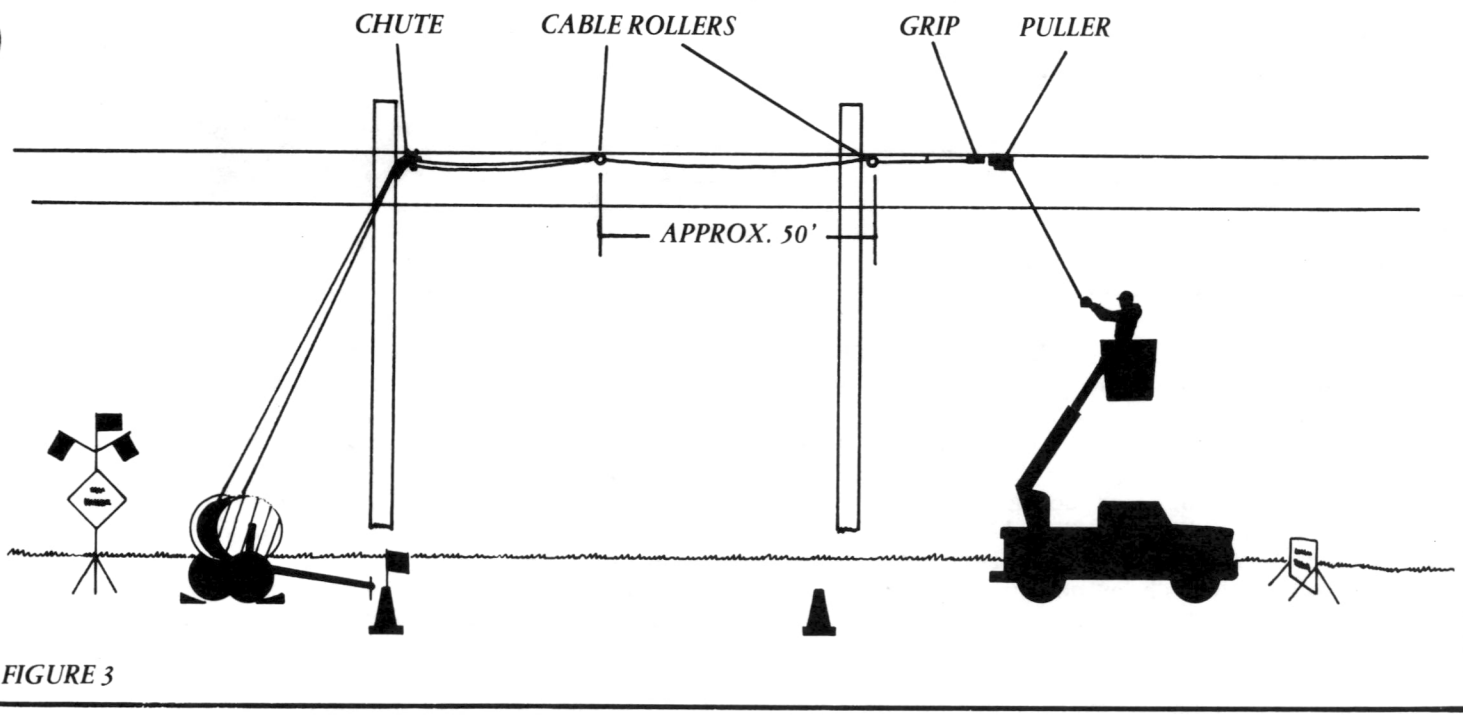


FIGURE 3

The cable reel trailer is unhooked from the truck and the tongue of the trailer positioned so that it points toward the pole or location where the cable is to pay off the reels into the stationary chute or rollers. The trailer should be approximately 50 feet away from this location with the trailer wheel chocks in place. All safety equipment should be distributed along the route for safe working conditions.

The strand chute and pole bracket are installed on the first pole and the 45° cable block secured to the bracket. At the same time, the cable puller, if used, is installed onto the strand. The rotating eye pulling grips are then placed on the ends of all of the reels of cable to be pulled into place. The pulling grips are attached to the swivel eyes on the cable puller after the cables have been properly positioned across the rollers of the 45° corner block used as the stationary cable chute.

If conditions dictate that the cable can be pulled into place span by span with a pulling line attached to the cable or cable puller, the pulling line should be attached and the cable pulled into place, span by span. Adequate cable blocks (rollers) are placed on the strand at approximately 50 foot intervals with a block-lifting tool. After the cable has been pulled past each cable block location by approximately 50 feet, the tension on the cable is relaxed and the cable(s) are lifted onto the cable block (rollers) with the cable lifter. See Figure 3.

This same procedure is followed span by span until the cable reaches the point where the lashing process is to commence.

As the cable is pulled in at locations where the cable makes turns 10° to 45°, a 45° cable block assembly is installed on the strand or pole. The 90° cable block is utilized at all locations greater than 45° and up to 90°. The cable should not be pulled around more than one 90° turn. See Figure 4.

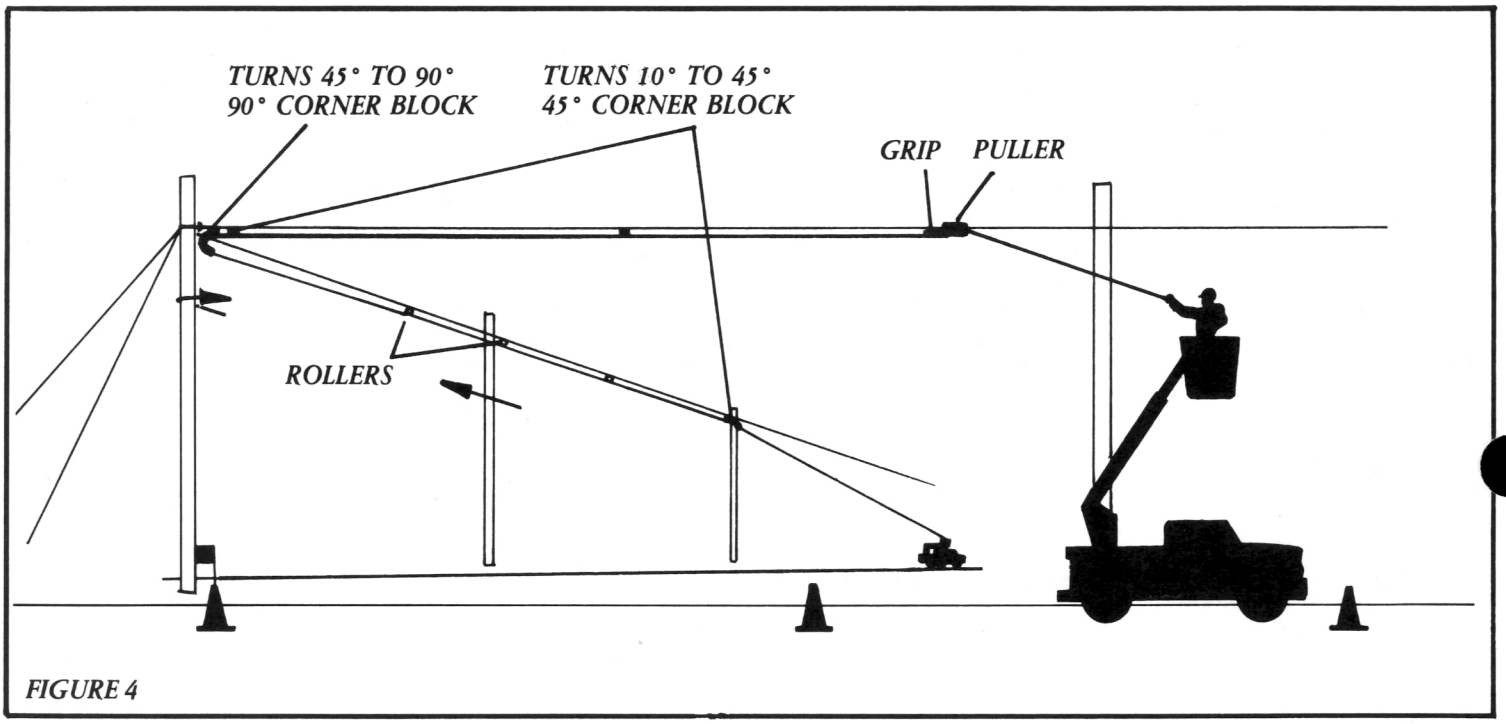


FIGURE 4

INSTALLATION PROCEDURES - BACK PULL - WINCH - LASHING CABLE

If conditions dictate that the length of the route or number of cables being pulled requires the use of the winch, the following procedures are followed:

All cable blocks (rollers) are placed on the strand with the cable block lifting tool, the entire length of the cable run. All 45° and 90° cable blocks (rollers) are also installed. From the anticipated end of the run, the winch is set up and adjusted toward the cable run. The winch cable is then strung along the cable run and placed over all of the cable blocks (rollers) at all non-stress locations. The winch line should run across steel winch line blocks (rollers) at all corners and other points of stress to avoid damage to the rubber or plastic rollers that are used in the cable roller blocks.

After the winch line has been connected to the cable or cable puller, the winch operator tensions the winch line and the cable reel brake is adjusted so that the pulling tension on the cable(s) does not exceed recommended pulling tension, according to individual cable specifications. A dynamometer should be utilized on all long cable pulls or where the tension on the cable might exceed the specifications.

The cable should be pulled into place with the winch span by span to the point where the lashing will commence. When using the cable puller, the cable rollers are removed and replaced as the puller passes. See Figure 5.

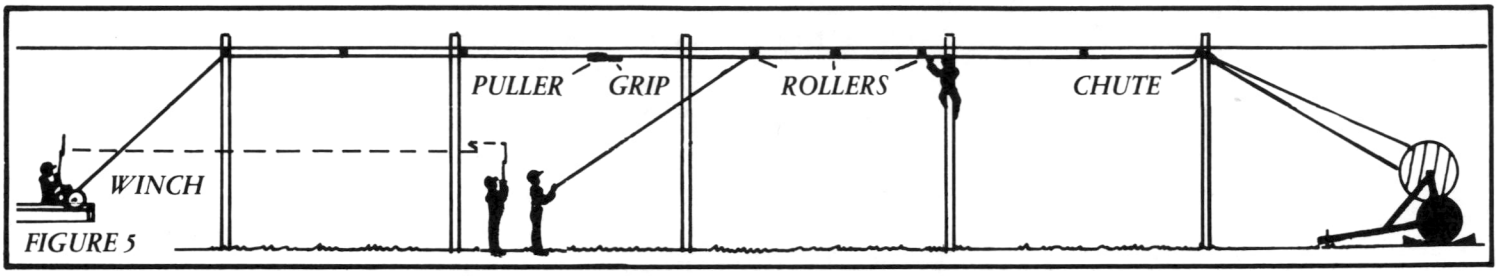


FIGURE 5

There should be adequate personnel in communication with the winch operator to watch the cable as it is being pulled into place. After the cable has been pulled into place, the lashing machine, cable block pushers and cable positioner, are placed on the strand and the cable properly positioned through them. The cable(s) is then lashed span by span back to the reel trailer location. As each span is lashed, excess cable slack is re-rolled onto the reels and all cable blocks (rollers) are removed. The cable at each of the pole locations is attached, as shown in Figures L-1 through L-10.

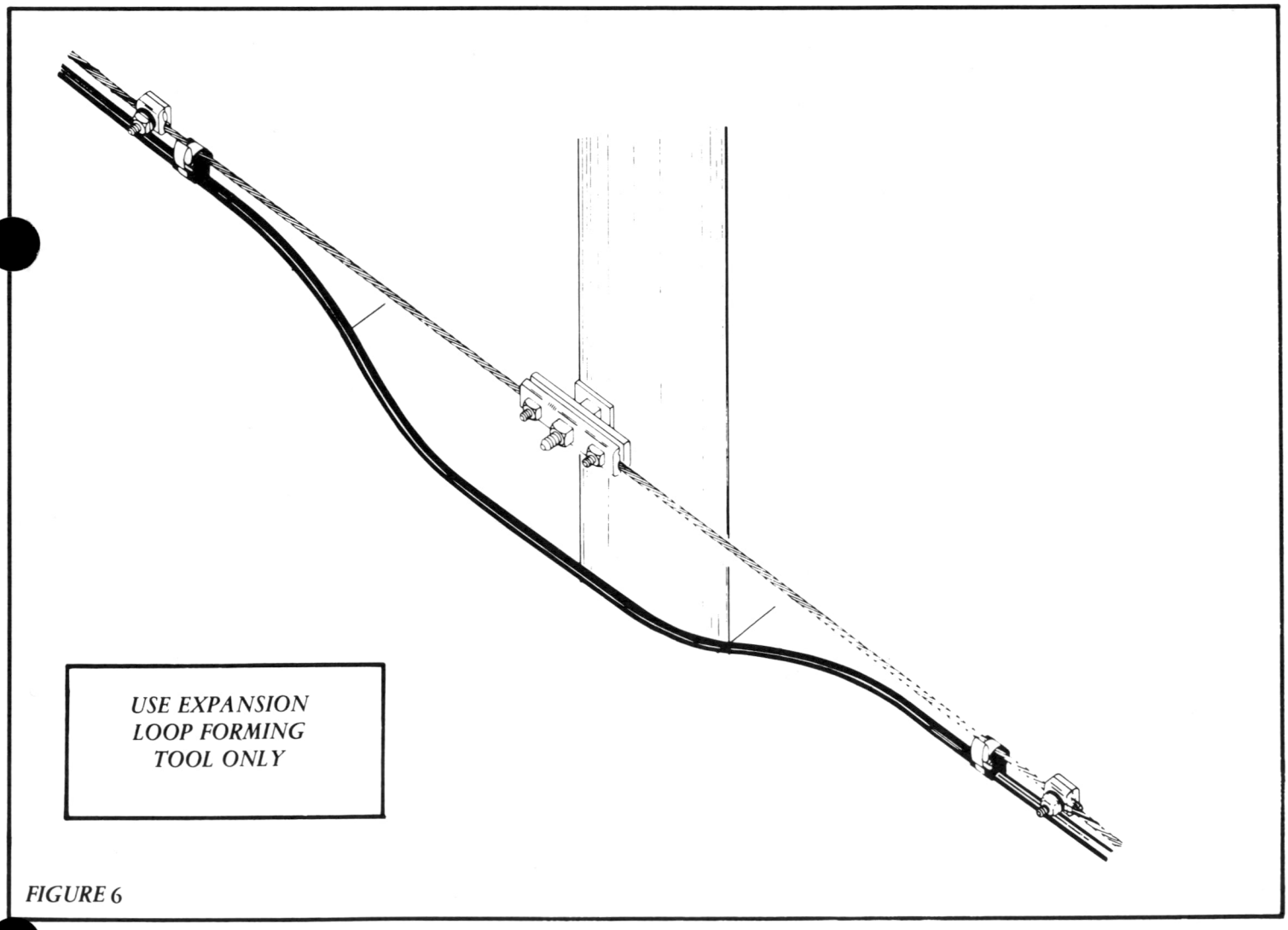


FIGURE 6

INSTALLATION PROCEDURES - EXPANSION LOOP

To allow for maximum temperature extremes, expansion loops are placed at each pole and at the input and output of all equipment. For locations where maximum temperature variations are not anticipated, users may modify the number and placement of loops based on their evaluations of installations in similar locations and under similar conditions.

In all cases, expansion loops should always be formed with a tool designed for the purpose and never by hand. See Figure 6.

CABLE HANDLING AND INSTALLATION PROCEDURES
LASHED CABLE
POLE FRAMING ILLUSTRATIONS
EXPANSION LOOP

	Page
FIGURE L-1 CABLE PLACING - STRAIGHT LINE	IL-73
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FIGURE L-3 CABLE PLACING - ANGLE POLE	IL-75
FIGURE L-4 CABLE PLACING - STRAIGHT LINE POLE CROSS-OVER	IL-76
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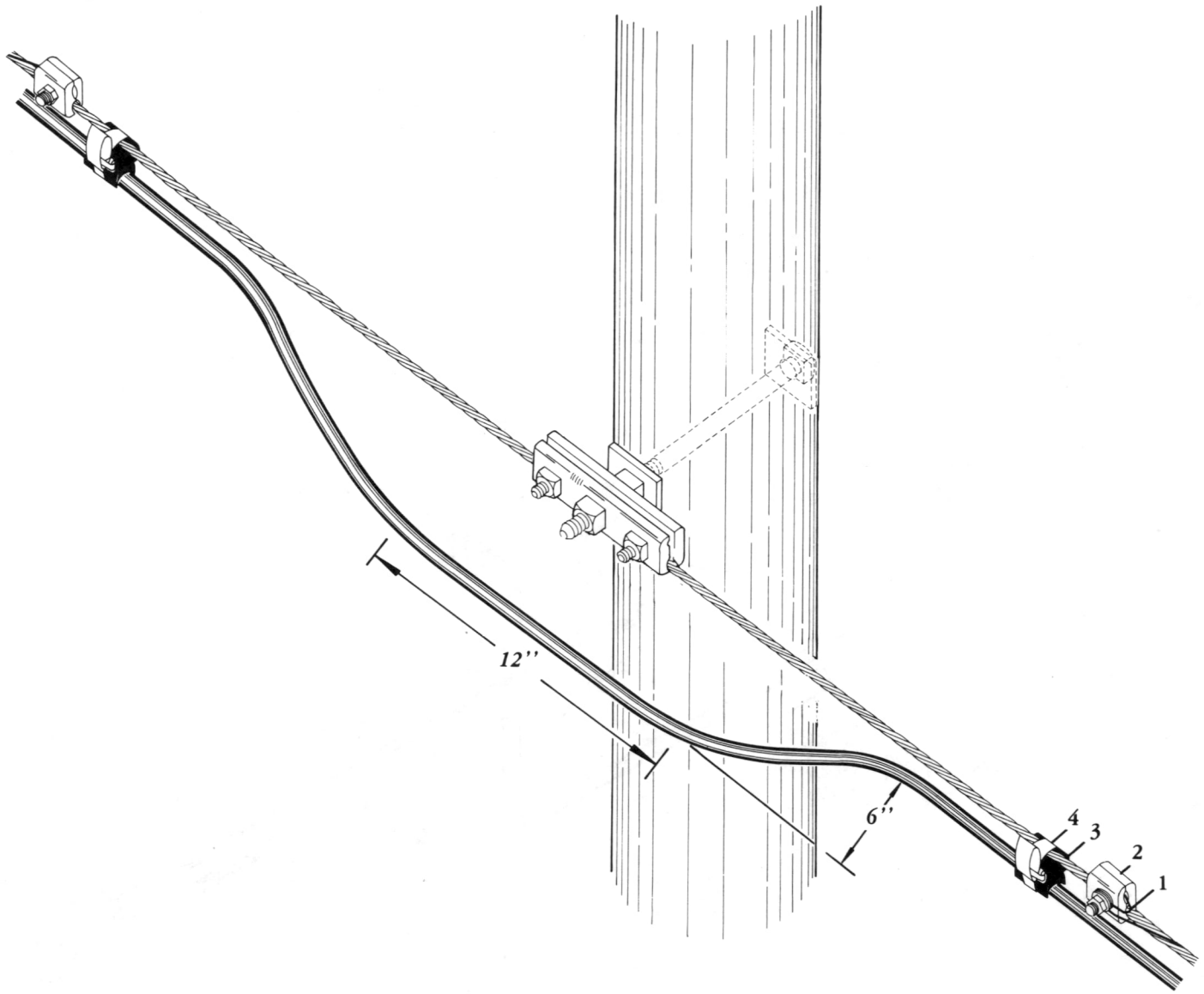
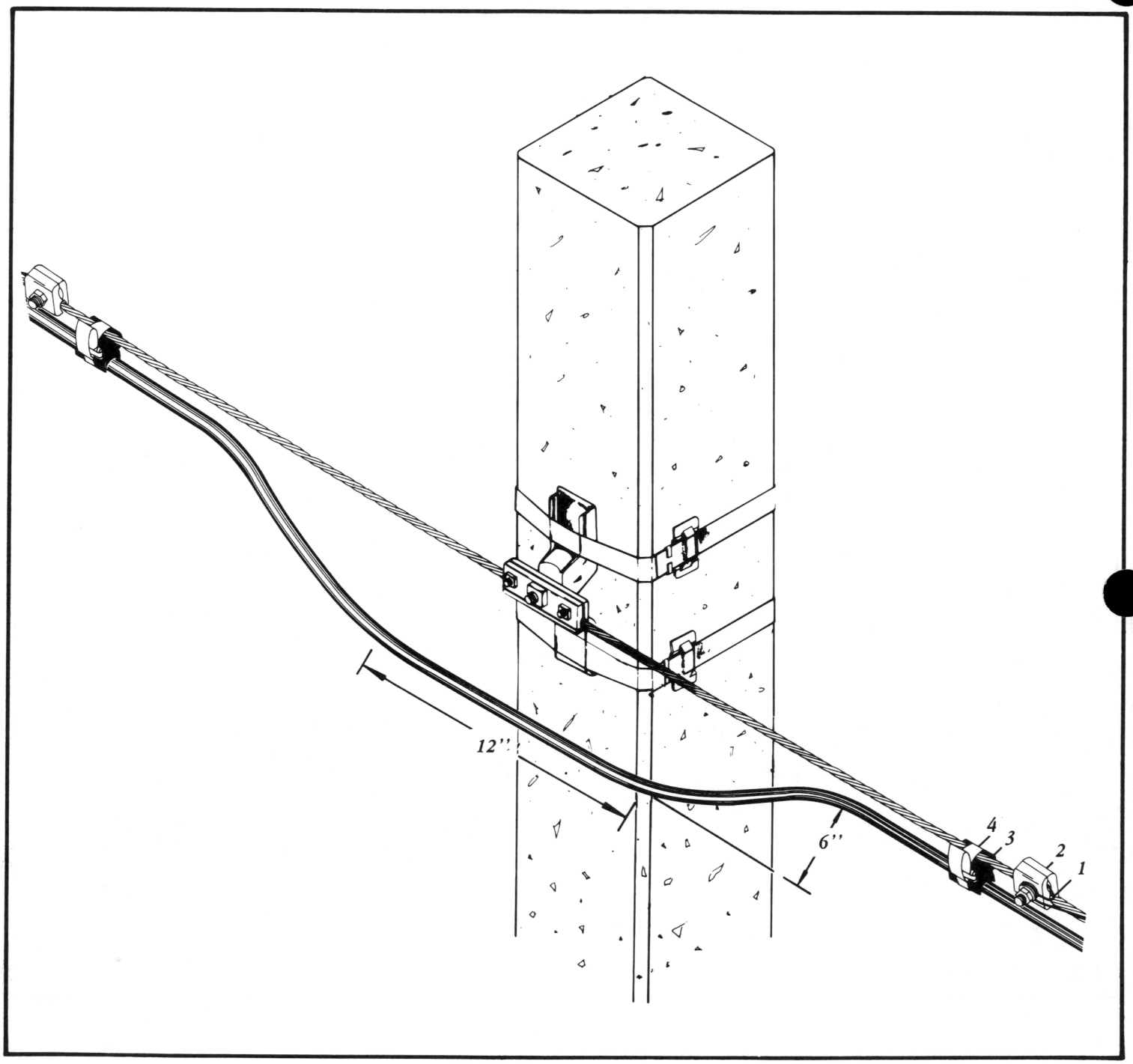
FIGURE L-9 CABLE PLACING - DEAD-END	IL-83
FIGURE L-10 CABLE PLACING - DOUBLE DEAD-END	IL-82



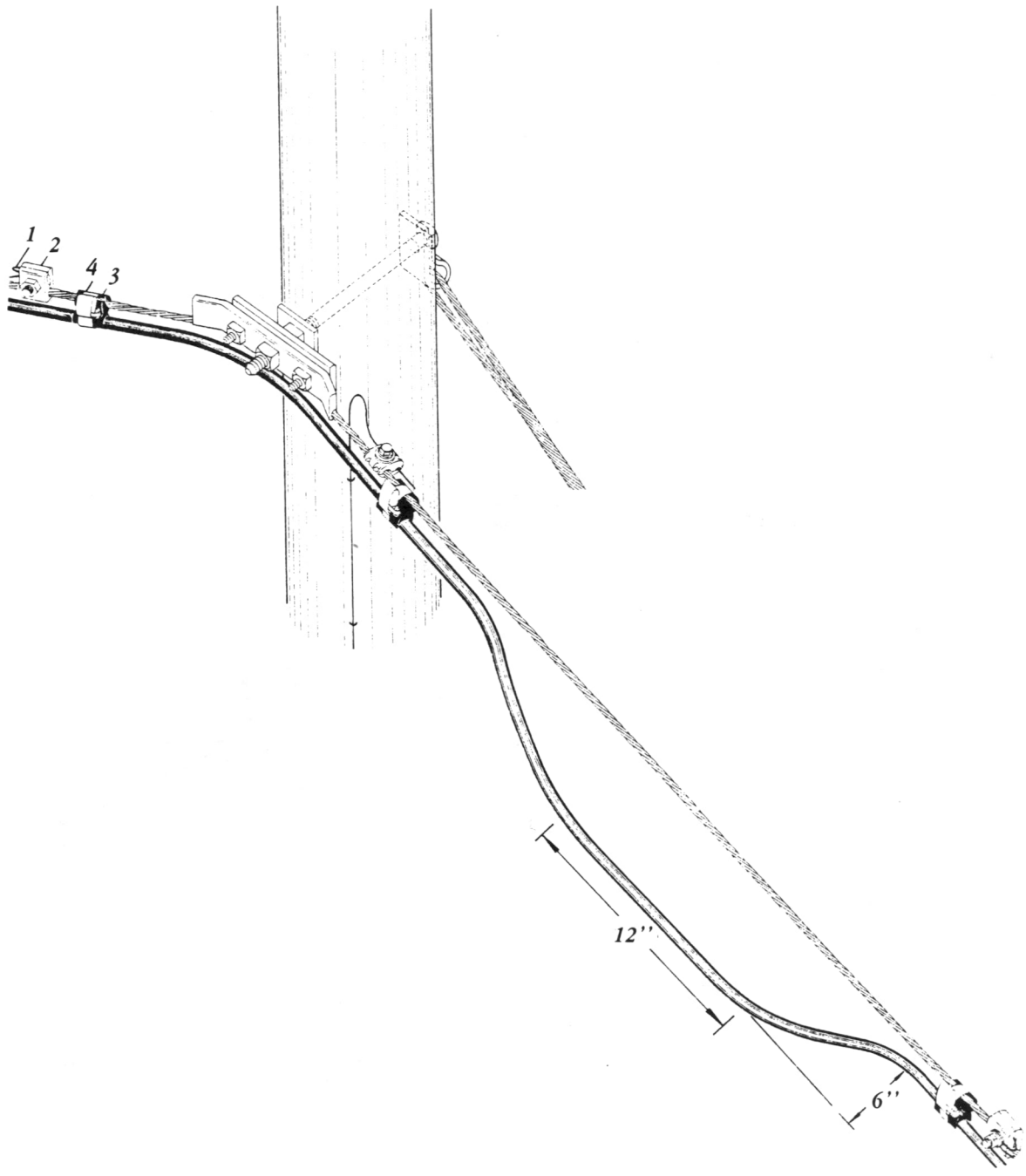
Item	*Description*
1	*0.045 Stainless Steel Lashing Wire*
2	*Lashing Wire Clamp*
3	*Cable Spacer*
4	*Cable Support Strap*

FIGURE L-1 CABLE PLACING - STRAIGHT LINE



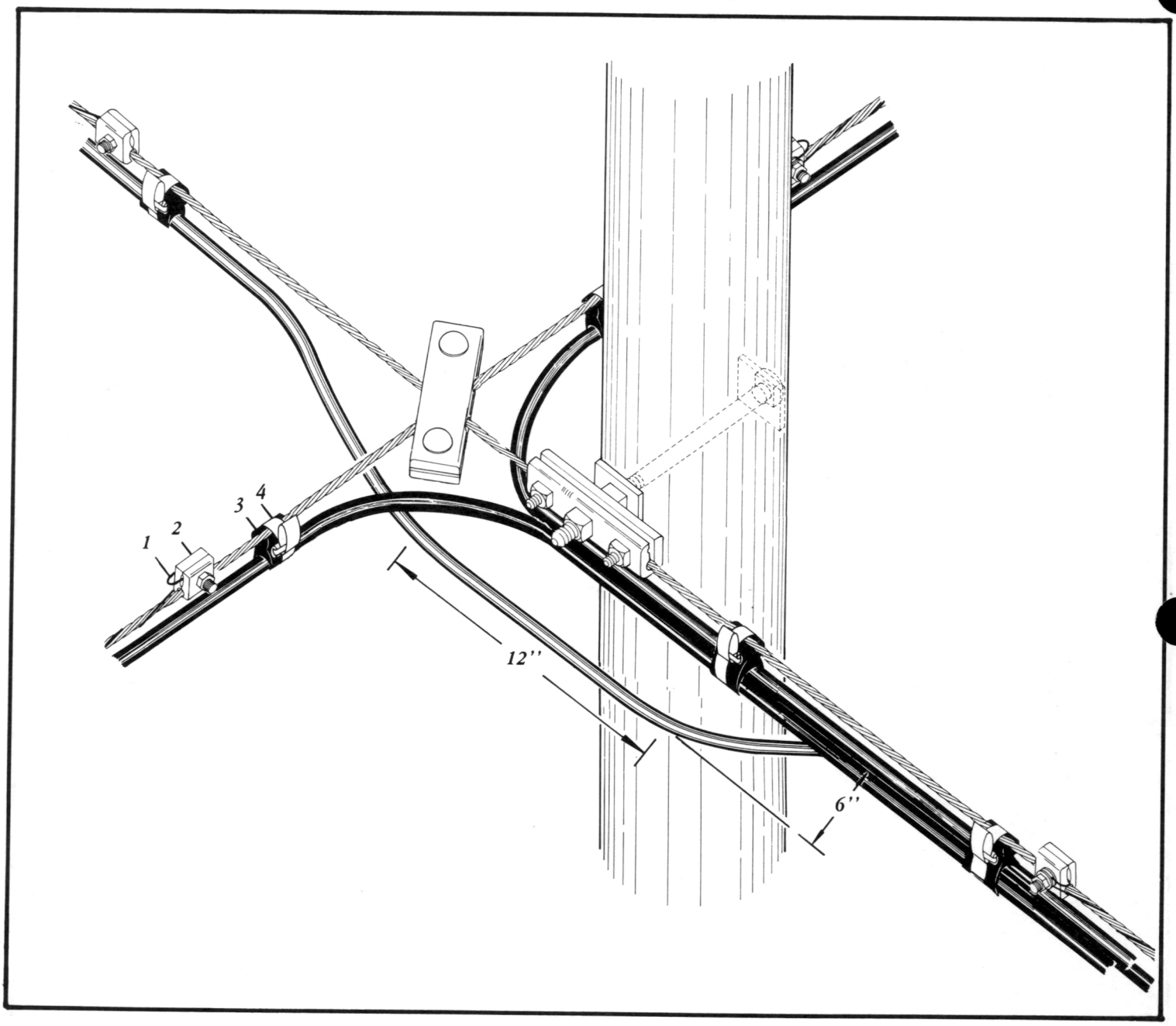
Item	Description
1	0.045 Stainless Steel Lashing Wire
2	Lashing Wire Clamp
3	Cable Spacer
4	Cable Support Strap

FIGURE L-2 CABLE PLACING - STRAIGHT LINE -STEEL OR CONCRETE POLE



Item	Description
1	0.045 Stainless Steel Lashing Wire
2	Lashing Wire Clamp
3	Cable Spacer
4	Cable Support Strap

FIGURE L-3 CABLE PLACING - ANGLE POLE



Item	Description
1	0.045 Stainless Steel Lashing Wire
2	Lashing Wire Clamp
3	Cable Spacer
4	Cable Support Strap

Map Legend

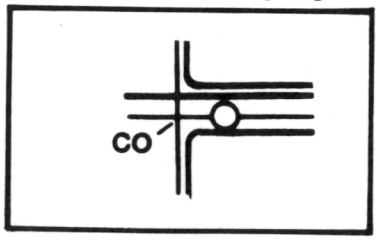
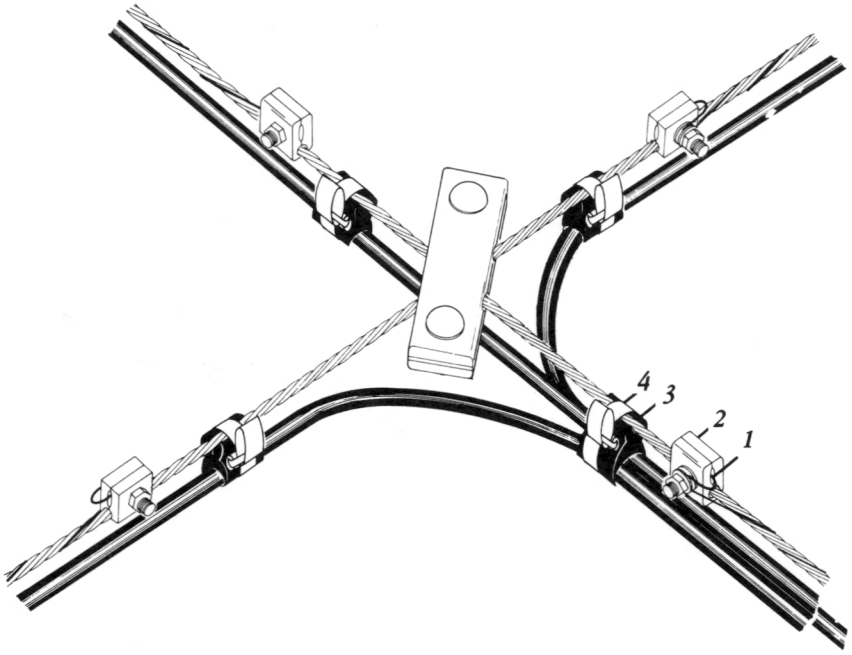


FIGURE L-4 CABLE PLACING - STRAIGHT LINE POLE CROSS-OVER



Item	*Description*
1	*0.045 Stainless Steel Lashing Wire*
2	*Lashing Wire Clamp*
3	*Cable Spacer*
4	*Cable Support Strap*

Map Legend

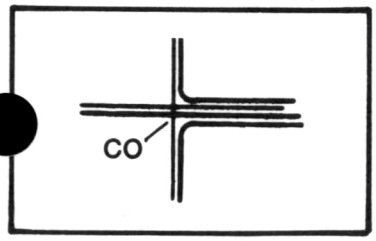
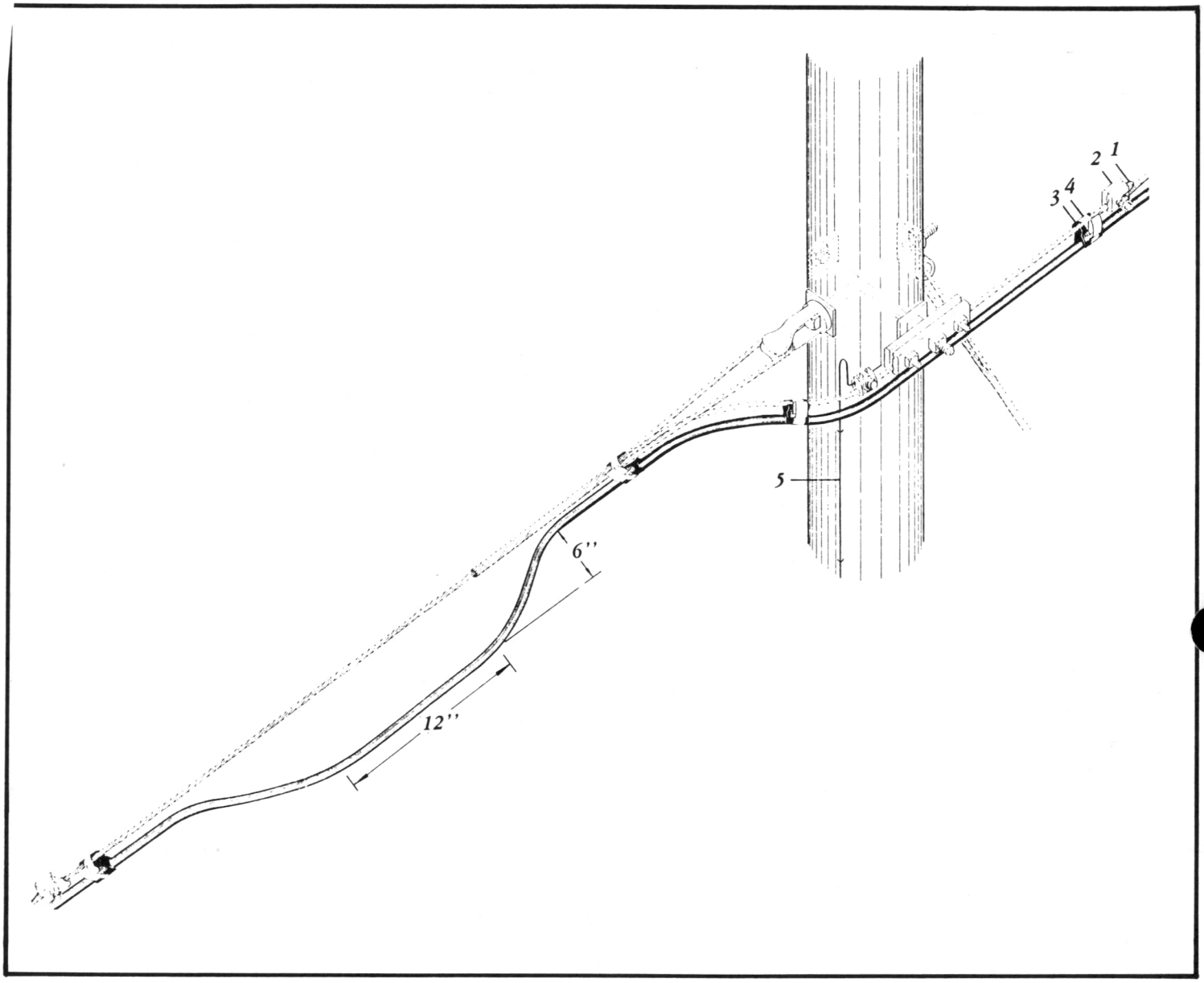
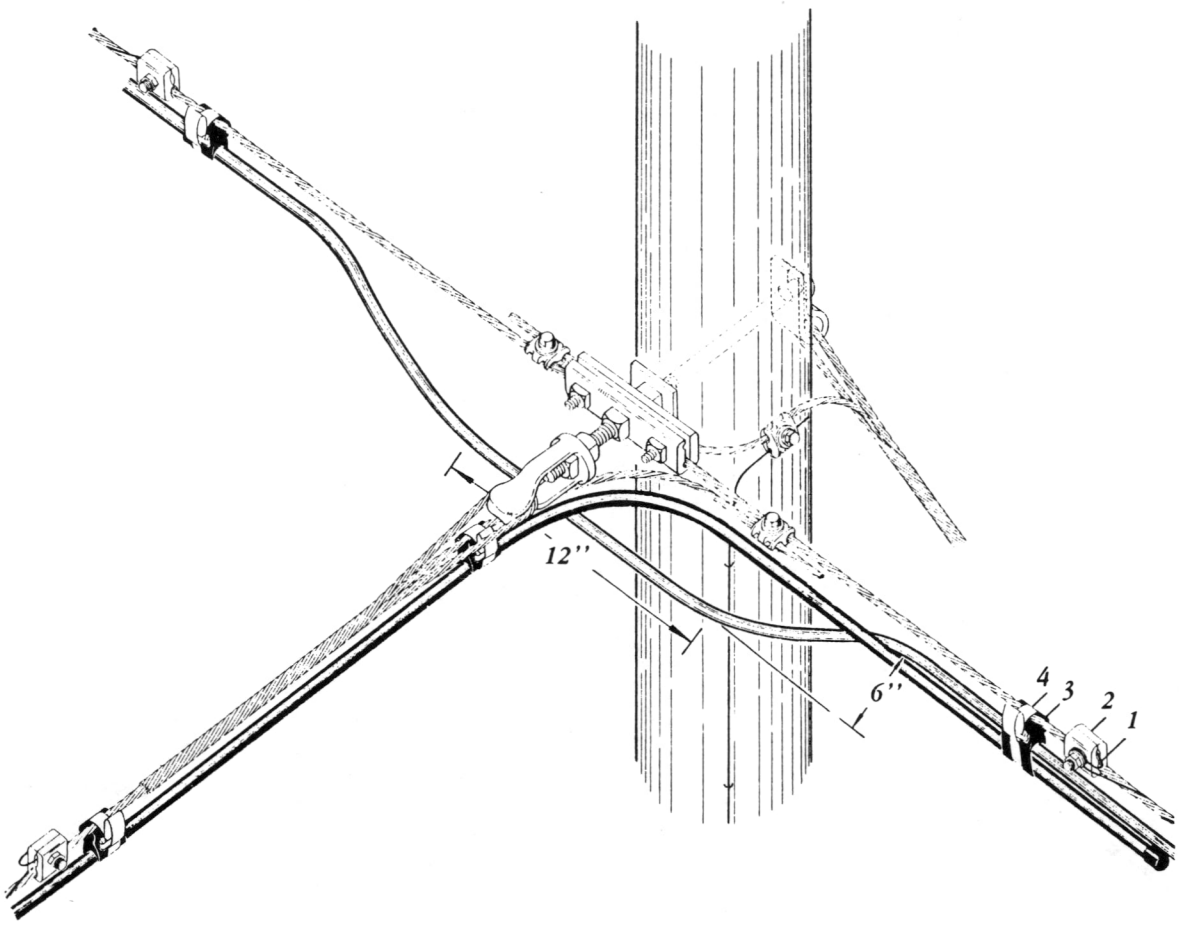


FIGURE L-5 CABLE PLACING - MID-SPAN CROSS-OVER



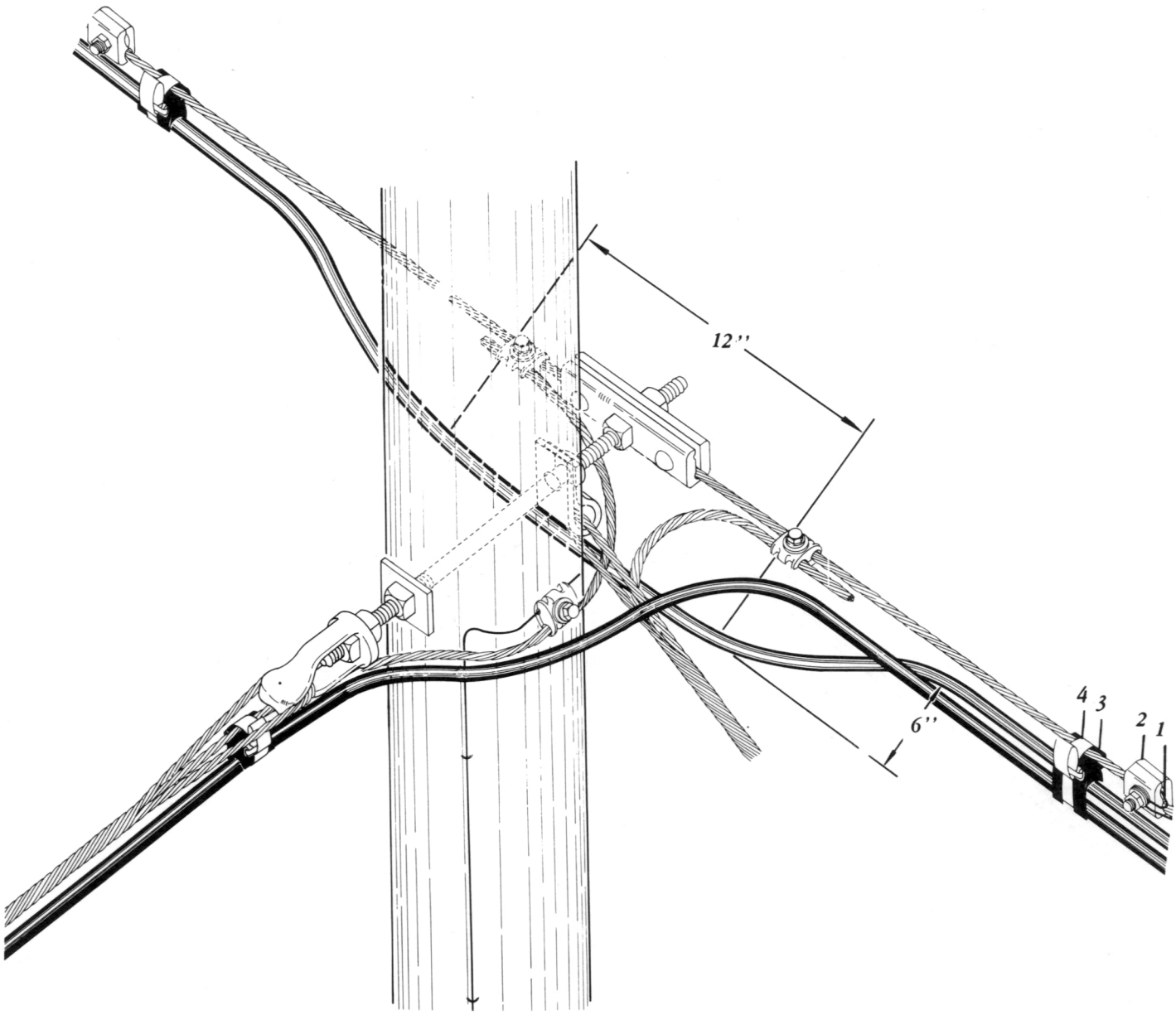
Item	*Description*
1	*0.045 Stainless Steel Lashing Wire*
2	*Lashing Wire Clamp*
3	*Cable Spacer*
4	*Cable Support Strap*
5	*Ground Wire*

FIGURE L-6 CABLE PLACING - FALSE DEAD-END



Item	Description
1	0.045 Stainless Steel Lashing Wire
2	Lashing Wire Clamp
3	Cable Spacer
4	Cable Support Strap

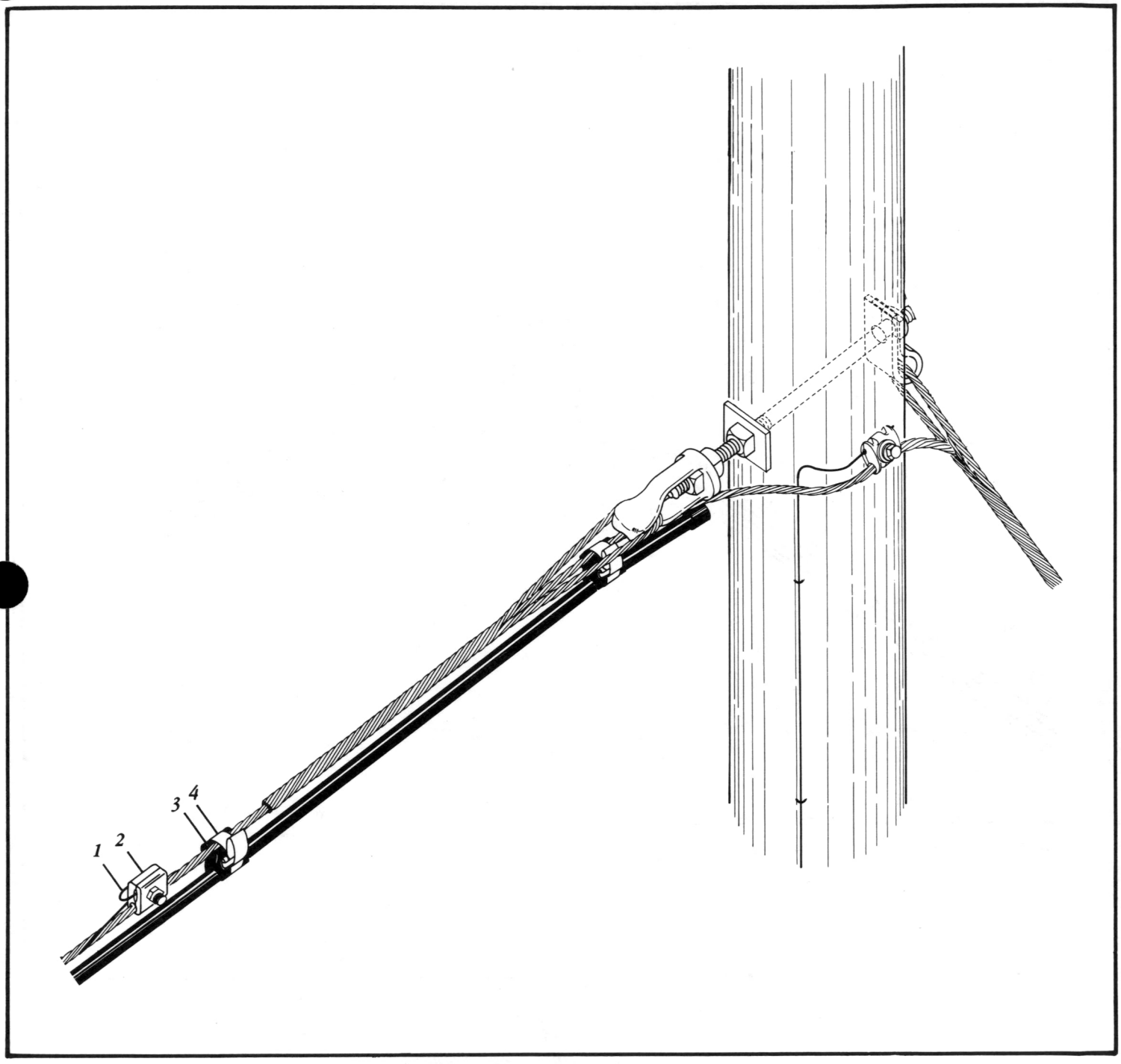
FIGURE L-7 CABLE PLACING - LINE POLE DEAD-END COMBINATION No. 1



NOTE: See Comm/Scope's specifications sheet for minimum bending radius.

Item	*Description*
1	*0.045 Stainless Steel Lashing Wire*
2	*Lashing Wire Clamp*
3	*Cable Spacer*
4	*Cable Support Strap*

FIGURE L-8 CABLE PLACING - LINE POLE DEAD-END COMBINATION No. 2



Item	Description
1	0.045 Stainless Steel Lashing Wire
2	Lashing Wire Clamp
3	Cable Spacer
4	Cable Support Strap

Map Legend

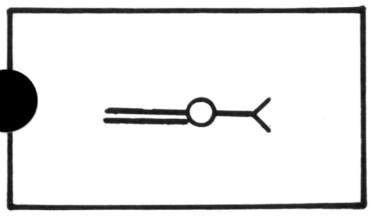
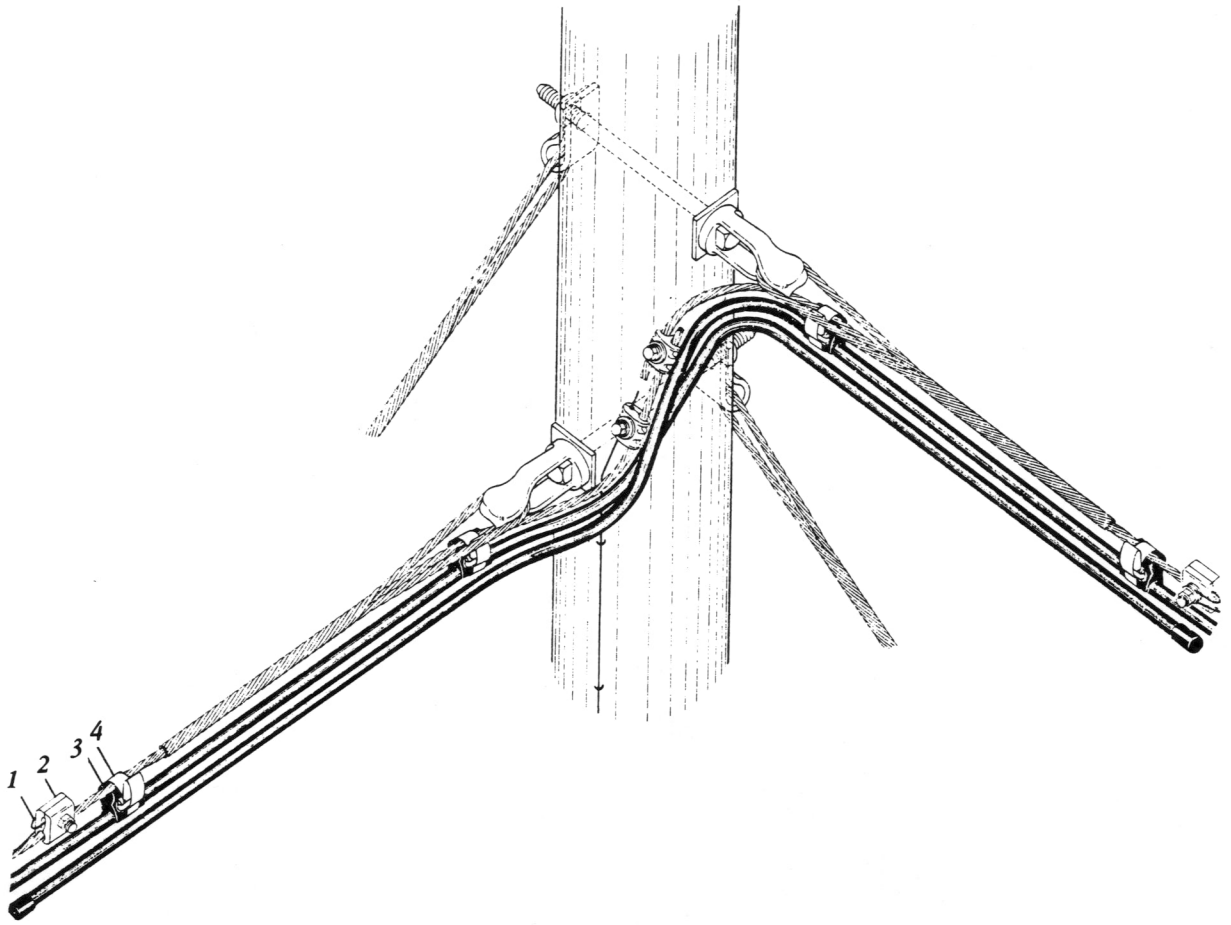


FIGURE L-9 CABLE PLACING - DEAD-END



NOTE: See Comm/Scope's specifications sheet for minimum bending radius.

Item	*Description*
1	*0.045 Stainless Steel Lashing Wire*
2	*Lashing Wire Clamp*
3	*Cable Spacer*
4	*Cable Support Strap*

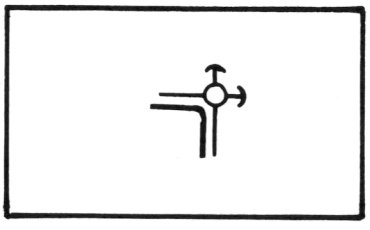


FIGURE L-10 CABLE PLACING - DOUBLE DEAD-END

Cable Handling and Installation Procedures

Underground Cable

UNDERGROUND CABLE INSTALLATION PROCEDURES

General

The installation of underground type coaxial cables should be undertaken with caution because of the many hazards that exist can damage the cable both during and after installation. The largest expense involved in underground is the opening and closing of the trench. It is quite often more economical to replace a portion of cable damaged in the installation process than to spend excessive amounts of money trying to protect the cable which is the smallest cost involved. Therefore, this section will recommend installation procedures designed to reduce the overall cost of underground construction, rather than provide ultimate protection to the cable. When using aluminum jacketed flooded cable, loss of an estimated four hundred feet (400') per mile may be expected in addition to the normal reel end losses. All of these installation procedures assume normal soil conditions.

Notifications

Prior to commencement of construction in any underground area, all persons and companies having buried facilities shall be notified for assistance in locating their respective facilities. After notification, these facilities are found by locators and small flags are placed over their locations.

Precautions

All trenching and plowing shall be in accordance with local requirements and permits. All trenching, boring and plowing should be confined to that which can be completed in not more than two (2) working days. All open trenches and bore pits shall have proper barricades and lights and/or covers at all times where work is in process.

There are many different conditions which prevail when placing underground cable. The sets of circumstances covered by this section will deal with the installation of underground cable in easements, along streets in developed areas and across open areas.

Tools and Cable Reels

After selection of proper equipment according to specifications and guide lines established in this manual, and after properly loading the cable to be installed, proceed to the selected installation site and begin construction.

INSTALLATION PROCEDURES - EASEMENT ROUTES - UNDERGROUND CABLE

At the installation site where the cable is to be placed along backyard easements or area inaccessible by vehicles, the following procedures are good installation techniques. See Illustrations UG-1 thru UG-6.

The reel covers are removed and the inside reel flanges are carefully inspected to insure that the surface is smooth and free from nails or other imperfections which will damage the cable while unreeling.

Trenching - Single Cable Routes

The sod removal and small trenching machines are unloaded and taken into the first backyard where the first cable pedestal is to be placed.

First, the sod cutter cuts a strip of sod along the easement between the houses. Five foot (5') lengths of the cut sod are removed from the trench line the entire length of the yard. The trencher then digs as narrow a trench as possible and to a depth specified by the installation specifications applicable to the project. See the Illustrations UG-1 thru UG-6 in the back of this section.

If a fence is encountered on the side of the yard, the trencher or hand tools are used to cut the trench under the fence for access to the adjacent yard. This same process is followed until the trench reaches the next pedestal location. See Figure 1.

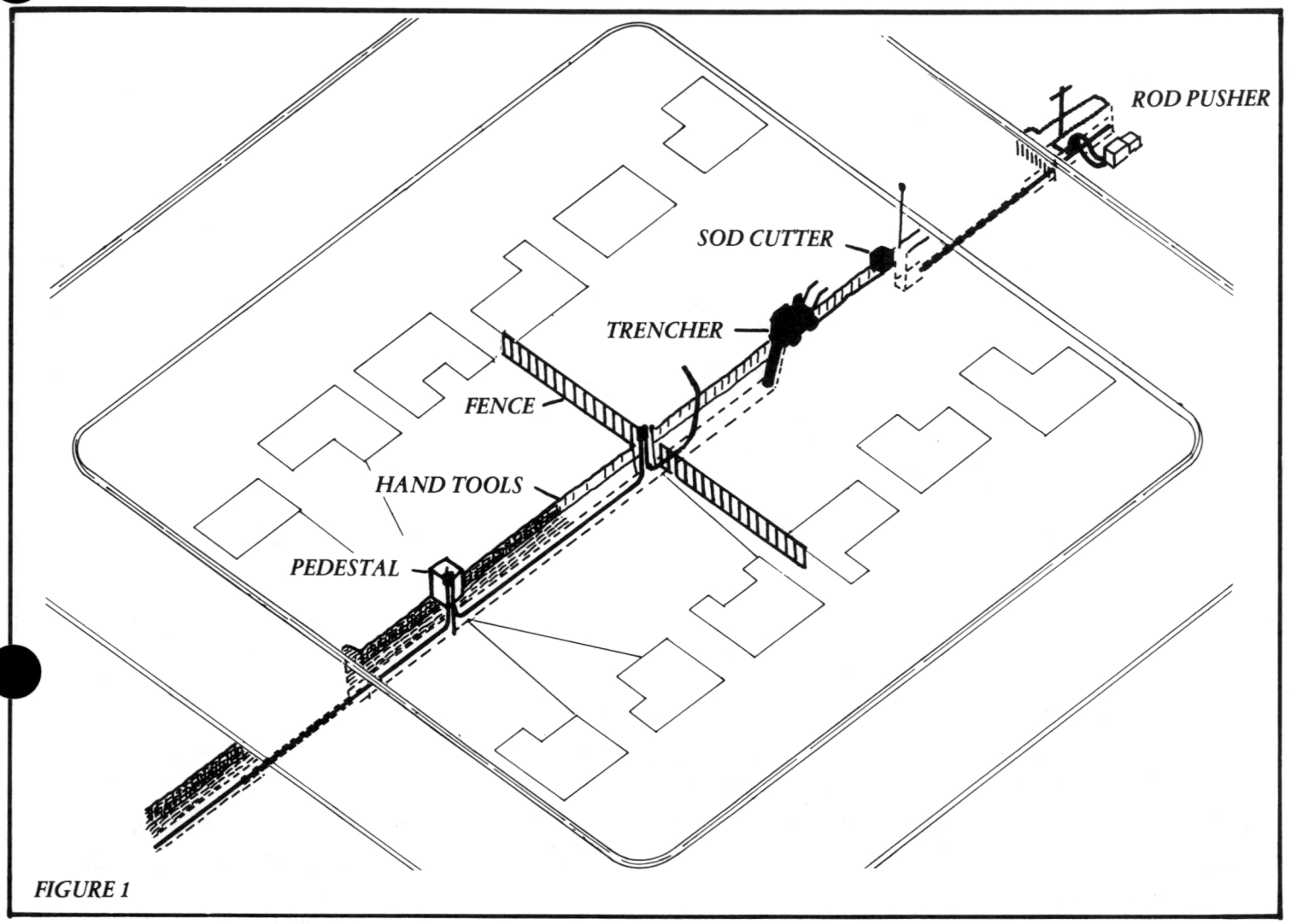


FIGURE 1

There are three ways to place the cable between the pedestals when placing cable in easements.

1. Position the reel trailer on the street at the end of the easement. Then pull the cable along the easement route feeding it into the open trench and under all fences, through all bores and other obstacles.

2. Position the reel trailer on the street in front of the house, and measure the distance between the pedestal locations. Then, unreel, measure and cut off the proper amount of the cable to be used. Pull it between the houses and feed it into the open trench and under all fences through all bores and other obstacles.

3. Unload the reel handlers from the transport vehicle and roll them into the back yards to the first pedestal location. Then, position the reel so that the cable will feed into the open trench toward the next pedestal location. Unreel the cable into the trench and under all fences, through all bores and other obstacles. See Figure 2.

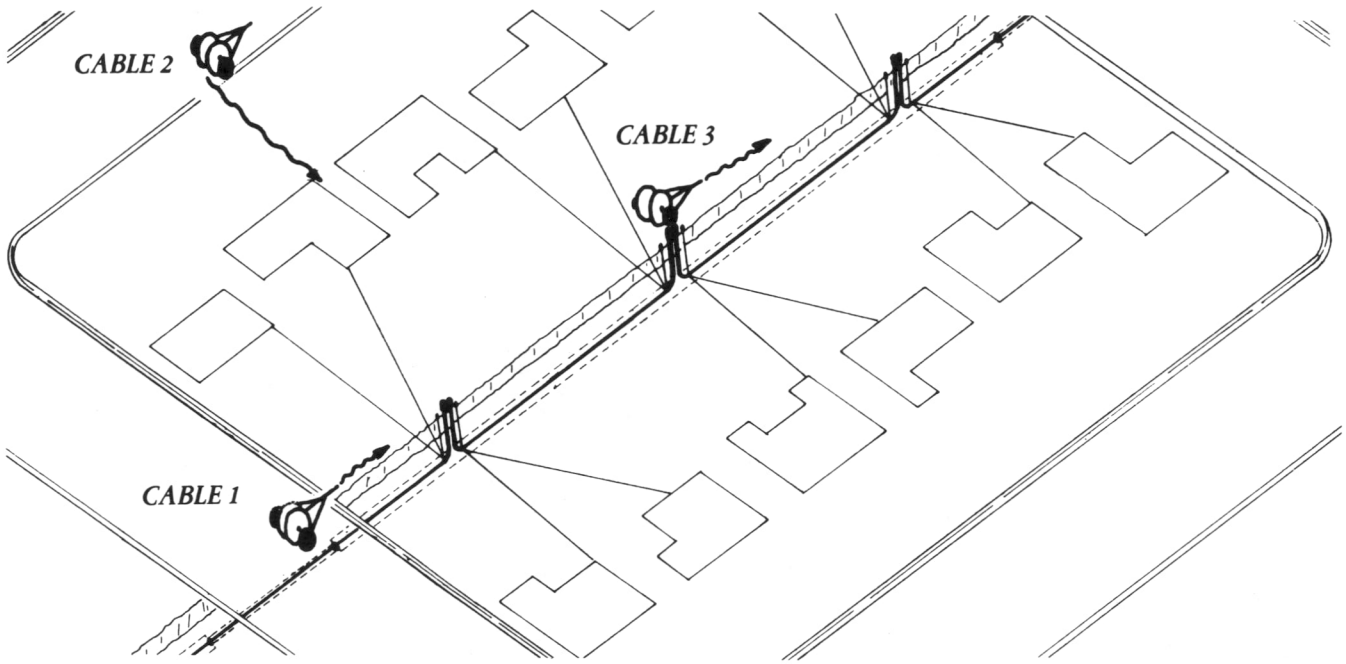


FIGURE 2

Prior to cutting the cable, be sure there is adequate cable coming out of the trench to reach the top of the pedestal. A Cable Bending Jig should be used to position the cable. (See Figure 3). When the cable is placed into the open trench under all fences, through all bores, and under all other obstacles between the pedestals, following one of the methods given above, the trench is backfilled with the material that was removed. If rock or other materials are encountered while trenching that may damage the cable when it is used to backfill the trench, a four inch (4'') layer of sand is put into the trench around the cable as a protection pad prior to backfilling. See Figure 3.

The trench line is then tamped to prevent settlement and the five foot (5') length of sod previously removed are replaced and tamped. The sod should be provided with adequate water and care until the roots have again become permanent. The six inch (6'') portion of each pedestal that is below ground level is filled with rock or gravel to provide proper drainage. This procedure continues backyard to backyard for the entire length of the easement route.

At all pedestal locations where the cable ends are cut to accommodate equipment, cable protection caps are placed on the cable ends to protect the cable from the elements. See Figure 3.

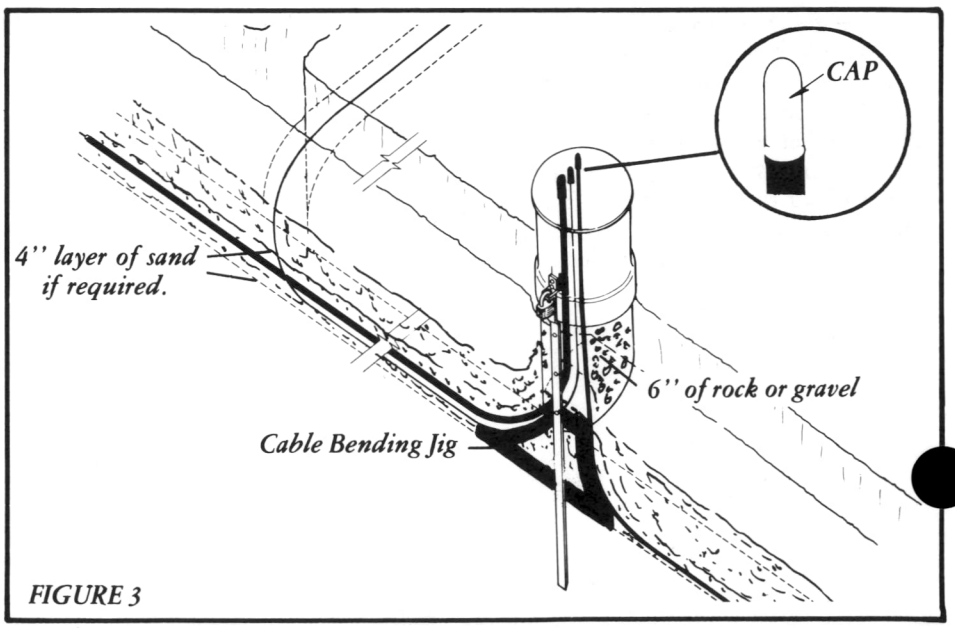


FIGURE 3

INSTALLATION PROCEDURES - UNDERGROUND
Plowing - Single Cable Runs

Machine or hand trench the pedestal site and a three foot (3') plow starter trench to the proper depth along the cable route. Next, machine or hand trench the next pedestal site in the cable run along with a plow blade starter trench three feet (3') long on each side of the pedestal site. If a fence or other obstacle is encountered between these two pedestal sites, dig a trench three foot (3') long plus the length of the plow machine on one side and under the fence or obstacle for stopping the plow and a three foot (3') starting trench on the opposite side of the fence or obstacle.

The cable is unreeled according to one of the three cable unreeling procedures described in the Trenching Single Cable instructions given on page UG-85 and UG-86 of this section. The cable is placed along the plow route under all obstacles between the pedestals. The vibrating plow is positioned facing the plow route and the blade is lowered into the three (3') foot starting trench. The cable is fed through the cable chute on the vibrating plow blade into the open trench.

The vibrating plow machine then plows the cable into the ground to the next, open receiving trench in the plot route. The cable is removed from the plow blade chute and the vibrating plow machine is relocated to the next cable plowing starting trench in the route.

The cable is fed into the pedestal location and all of the trenches are backfilled and the plow route is tamped and watered.

This procedure continues pedestal to pedestal to the end plow route.

INSTALLATION PROCEDURES - UNDERGROUND
Boring

Where driveways, sidewalks and other short bores are encountered along the route, boring pits are dug on each side of the areas and a rotating boring machine is used to bore or compact holes under these areas with adequate diameter to accommodate the cable or conduit to be used. See Figure 4.

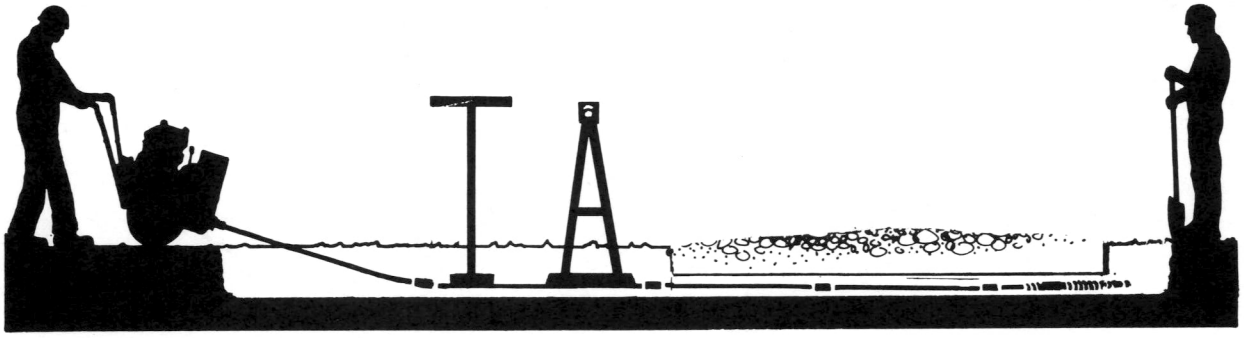


FIGURE 4

Follow These Steps When Boring:

1. When using rotating boring machines, connect together adequate boring steel or rod to reach through the bore. Attach the bit to be used onto the boring steel and the steel to the rotation machine.
2. Place the bit and boring steel into the boring pit. Place a target at the desired receiving pit on the opposite side of the area to be bored. Place the guide on the boring steel and align the steel so the guide is pointing at the target. Then level the first section of steel and start the machine. As the bit pulls itself through the bore, keep the guide on the target and the boring steel level.
3. When the length of boring steel required to reach through the bore has been used, stop the machine. Many times the boring bit hits an obstacle and is diverted away from the target site. Therefore, take a pipe locater and locate the boring bit near the target site. Then dig a receiving pit and locate the bit.
4. Replace the boring bit with a reamer/swivel eye if a larger hole is required, or a swivel eye attachment if the hole size is adequate.
5. Attach a rotating eye grip to the end of the cable, conduit or pull line and the eye of the grip to the swivel eye on the boring steel. Then, start the machine and pull the steel back through the bore.
6. When the swivel eye and rotating eye grip are pulled back to the boring pit, remove them and pull the balance of the cable, conduit or pull line required through the bore.

Each bore is completed according to instructions given above.

Boring Streets

Where streets of average width are encountered along the route a rod pusher is used instead of a rotating boring machine. See Figure 5.

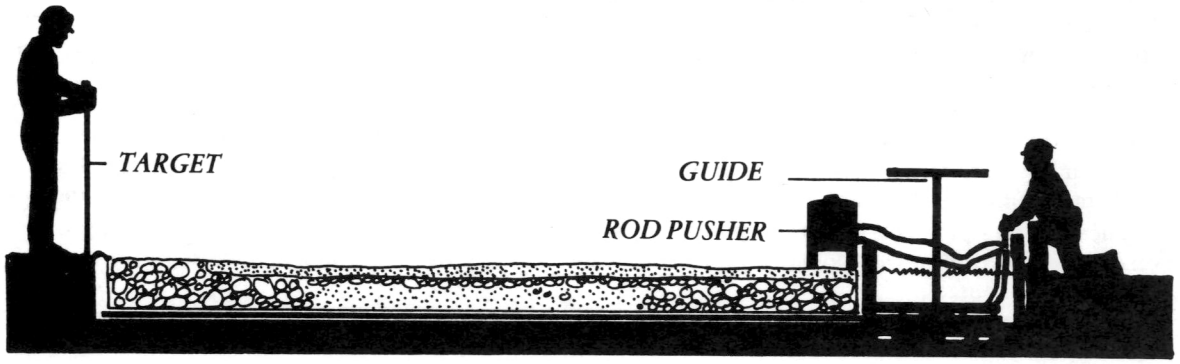


FIGURE 5

Steps 1 through 6 under rotating boring machines are taken when using a rod pusher except the rod sections are put together and leveled as they are pushed through the bore and taken apart as they are pulled back.

Boring the sidewalks on each side of the street is usually a separate boring operation, however, the same boring procedures apply.

The trench is then cut along the easement to line up with the bore. The cable is placed in the trench on each side of the bore under all fences and obstacles to the pedestal location, and the bore pits and trenchs are back-filled with the materials which were removed using four inches (4'') of sand, if required.

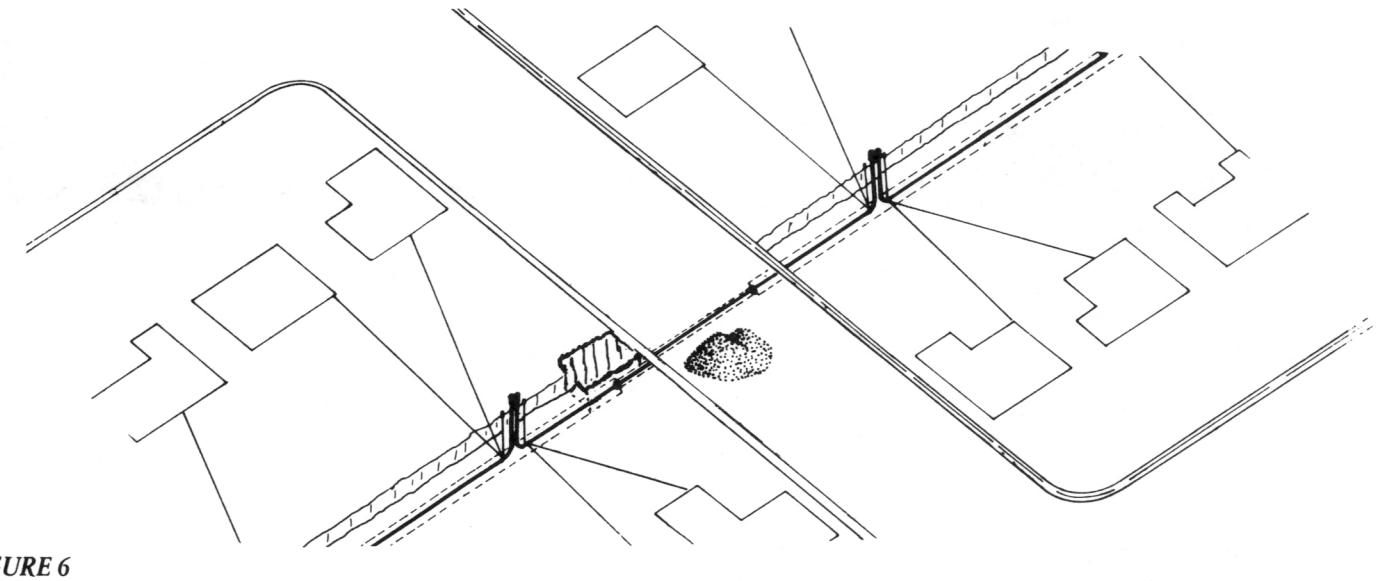


FIGURE 6

When back-filling bore pits, an optional method is to backfill all but the top one foot (1') with sand to prevent settlement, and then the last foot with the material which was removed. All material is tamped to prevent settlement and all sod is replaced, tamped and watered. When sand is used, the balance of the material dug from the bore pits is loaded and hauled from the site.

Each street encountered in the run is completed according to instructions given above.

INSTALLATION PROCEDURES - STREET CUTS

When boring is not possible because of rock or other conditions which prevent boring, use these procedures:

1. Saw two grooves four inches (4'') apart through the street surface material with an asphalt or concrete saw blade attached to a sawing machine.
2. Remove the material between these grooves with a jack hammer and hand tools, then trench the street crossing to the desired depth.
3. After all trenches are tied together with bores under the curbs and gutters, sidewalks etc., feed the cable into the open trench, through all bores and under all other obstacles to the pedestal locations.
4. Backfill the trench across the street with a slurry mix (one (1) sack cement to one (1) yard of sand and water) up to within two inches (2'') of the street surface. Allow one day for the slurry mix to set, then refill the balance of the street cut with asphalt and compact with a small asphalt compactor.
5. Backfill the trench on each side of the street cut according to the other trench backfill instruction in this section. See Figure 7.

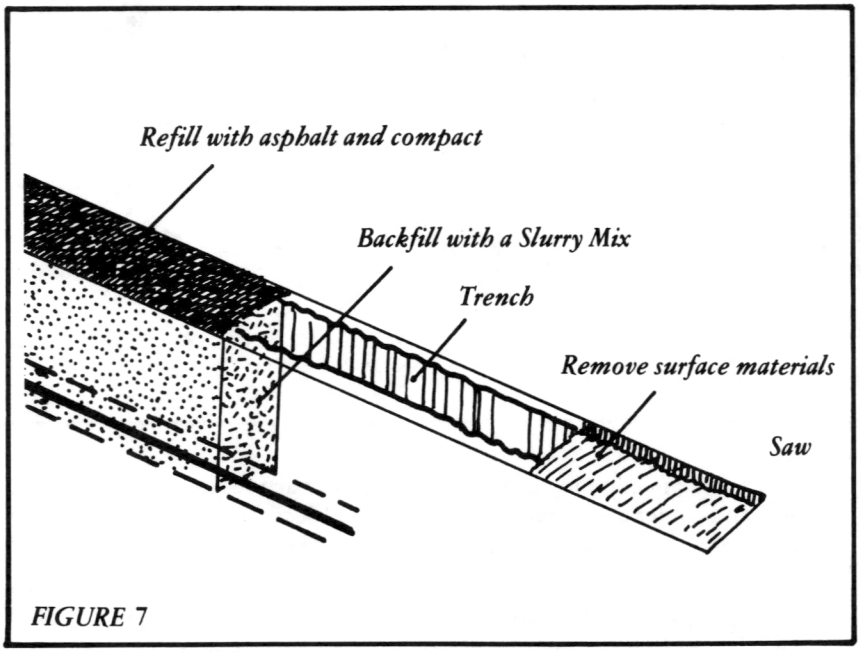


FIGURE 7

Trenching - Multi-Cable Runs

Those procedures followed under ''Trenching - Single Cable Runs'' are used except all trenches and street bores are left open until all cables are placed and are terminated in their respective pedestals.

The open trench length may be kept short with good design techniques and installation planning. Then all trenches and bore pits are backfilled and the sod replaced.

INSTALLATION PROCEDURES - STREET ROUTES - UNDERGROUND CABLE

At the installation site where the cable is to be placed along streets, the following procedures are good installation techniques. (See Illustration UG-1 thru UG-6.)

Trenching - Single Cable Routes - Streets

The sod removal, trenching and boring machines are unloaded on the street at the beginning of this underground route.

First the sod cutter cuts a strip of sod along the street between the first two pedestals to be placed. Five foot lengths of the cut sod are removed from the trench line between the pedestal locations.

With a trencher or backhoe, cut bore pits at all street crossings, driveways, and sidewalks betweeen pedestals and routes and bores. (See Figure 8.)

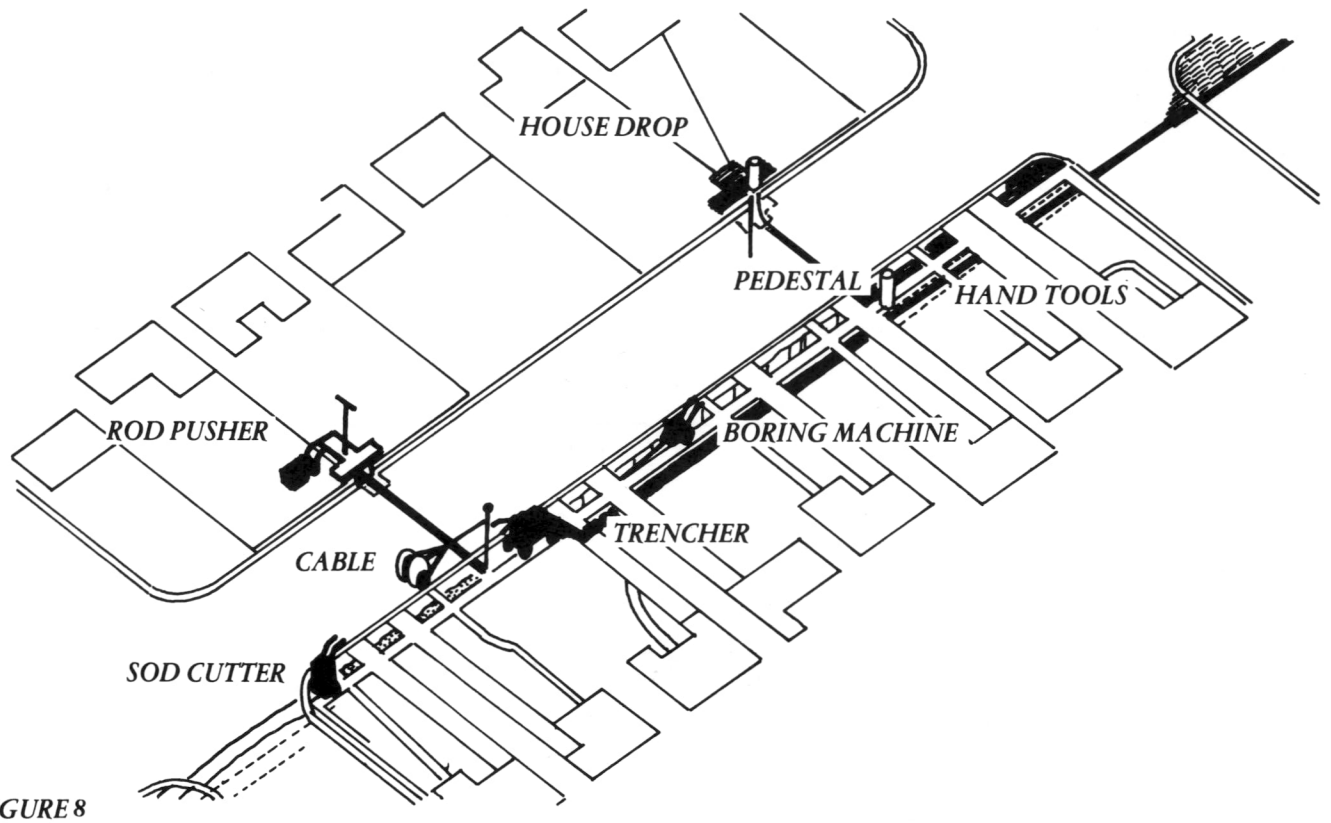


FIGURE 8

All bores are completed per the boring instructions, and the cable is unreeled into the open trench through all bores and under all obstacles to the pedestal locations. The pedestals are set and the trench and bore pits are properly backfilled. The sod is replaced, tamped and watered. This process continues between all pedestals along the streets.

Trenching Multiple Cable Routes - Streets

When multiple cables are to be buried, the same procedures described under single cable routes apply, except that all trenches and bores are left open until all cables are placed and terminated in all pedestals along the route.

INSTALLATION PROCEDURES - OPEN AREA ROUTES

At the installation site where the cable is to be placed along open areas accessible to equipment and with no crossing obstacles follow these procedures:

Trenching/Plowing - Cable Routes

1. Unload the trenching, sod removal or plowing machine and other tools; take them to the first pedestal location.
2. If trenching, place an offset string line along the trench route between the pedestal location for the trencher to follow in order to dig a straight trench. Cut and remove the sod along the route per the instructions on page UG-89 and start the trencher. Dig the trench past the next pedestal location. Unreel the cable into the open trench and form it across the cable bending jig. Backfill the trench with the backfill blade attachment on the trencher. Tamp the trench route to prevent settlement and replace, tamp and water the sod if removed. See Figure 8. This same procedure is followed between the balance of the pedestal locations along the balance of the trench route.
3. If plowing, trench a three foot (3') plow blade starting trench at the first pedestal location in the plow route. Place an offset string line along the plow route between the pedestal locations for the plow to follow in order to plow a straight line. Dig a six foot (6') plow blade stopping and starting trench at the next pedestal location. Unreel the cable along the plow route, then feed the cable through the plow blade chute into the open starting trench to the starting pedestal location. Plow the cable into the ground to the next stopping trench. Remove the cable from the chute on the plow blade and form it around the cable bending jig at the pedestal location. Place the cable in the starting trench and through the blade chute, then plow the cable to the next pedestal stopping trench. As each length along the route is plowed, place the pedestals, backfill the trenches, tamp the trenches and plow route and replace, tamp and water all sod which was removed.

This same procedure is followed the entire length of the plow route.

If streets or other obstacles that cannot be trenched or plowed are encountered, follow the boring instruction on pages UG-87 thru UG-88 of this section.

INSTALLATION PROCEDURES - CABLE PULLING

Where conduit is placed along the cable route or where cable is to be pulled into existing duct facilities follow these procedures:

1. When placing conduit, trench the route per the instructions on page UG-84 thru UG-86 of this Section. Then place the conduit into the open trench between the pedestals or manholes. Spot backfill the trench to hold the conduit into place as it is placed. Prior to placing the 90° elbows on the conduit ends at the pedestal locations, blow a pull line through the conduit. Pull the cable into the conduit. Cut the cable, allowing for adequate cable to reach the top of the pedestals on each end of the route. Slide the 90° elbows over the cable ends and secure them to the conduit. Then backfill the trench and replace the sod per previous backfill instruction. This same procedure is followed between the balance of the pedestals or manhole locations along the balance of the route.

2. When pulling cable into existing duct facilities, first remove the manhole covers, place a manhole guard rail, and safety equipment around the pull location and pump fresh air into the manholes with ventilating equipment. Next, place the cable reel trailer and pulling wench next to the manholes and attach cable rollers and feeders and wench cable blocks above and within the manhole so that the cable and wench line will freely roll into and out of the duct.

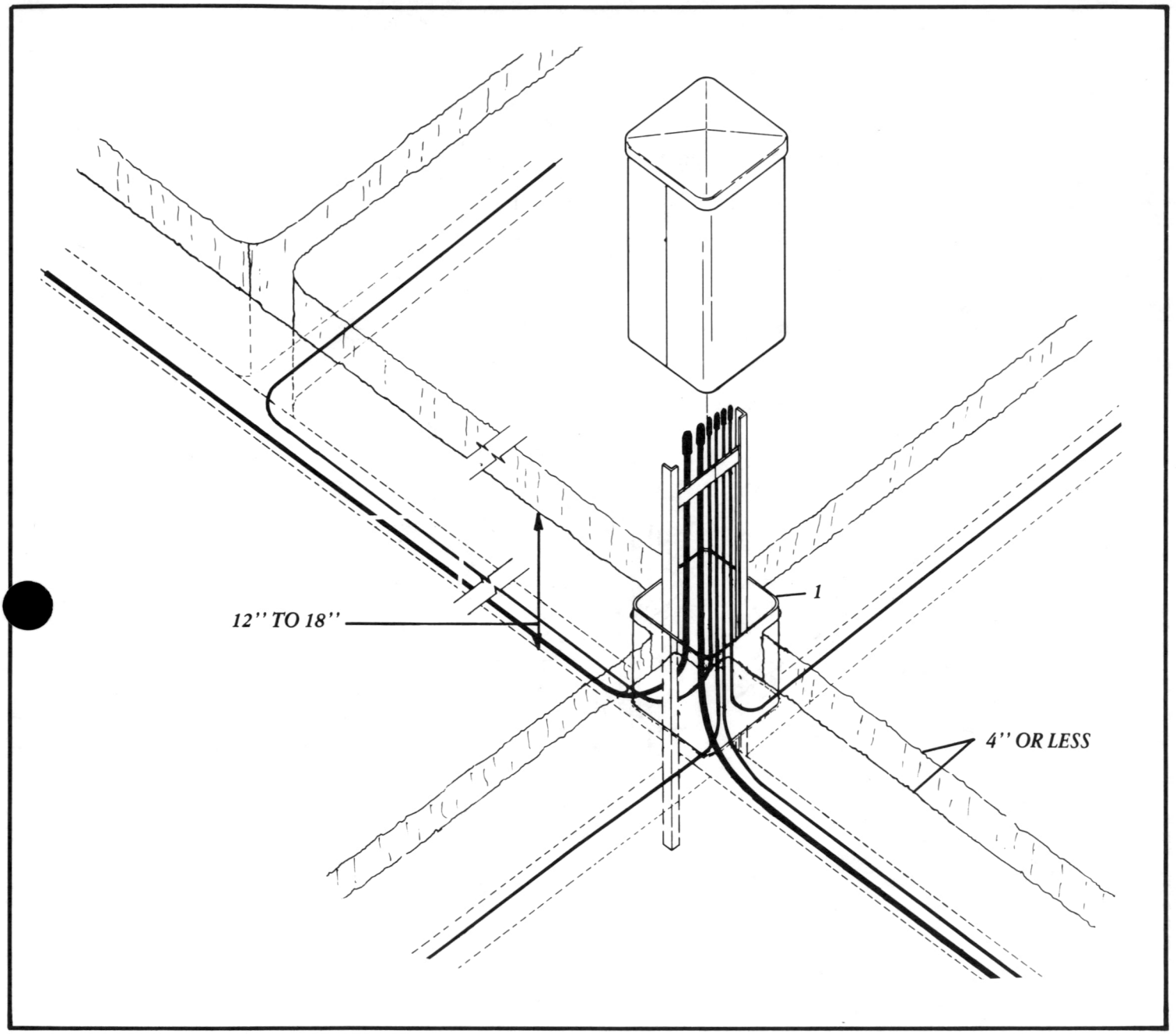
Blow a pull line through the duct and cable feeders attached to a line carrier designed to clean out water and dirt as it travels through the conduit. Attach the pull line to the wench cable and pull the wench cable into the duct with the pull line. Then slip a rotating eye pulling grip onto the cable end and attach the wench line to the eye.

Take up the slack in the wench line while feeding the cable and wench line over all rollers and blocks. As the cable comes off the reel apply a cable lubricating pulling compound to reduce friction as the cable is pulled through the duct. When pulling long and difficult routes use the dynomometer to measure the pulling tension on the cable to confirm that the maximum pulling tension specification of the cable is not exceeded.

UNDERGROUND CALBE INSTALLATION PROCEDURES
UNDERGROUND ILLUSTRATIONS

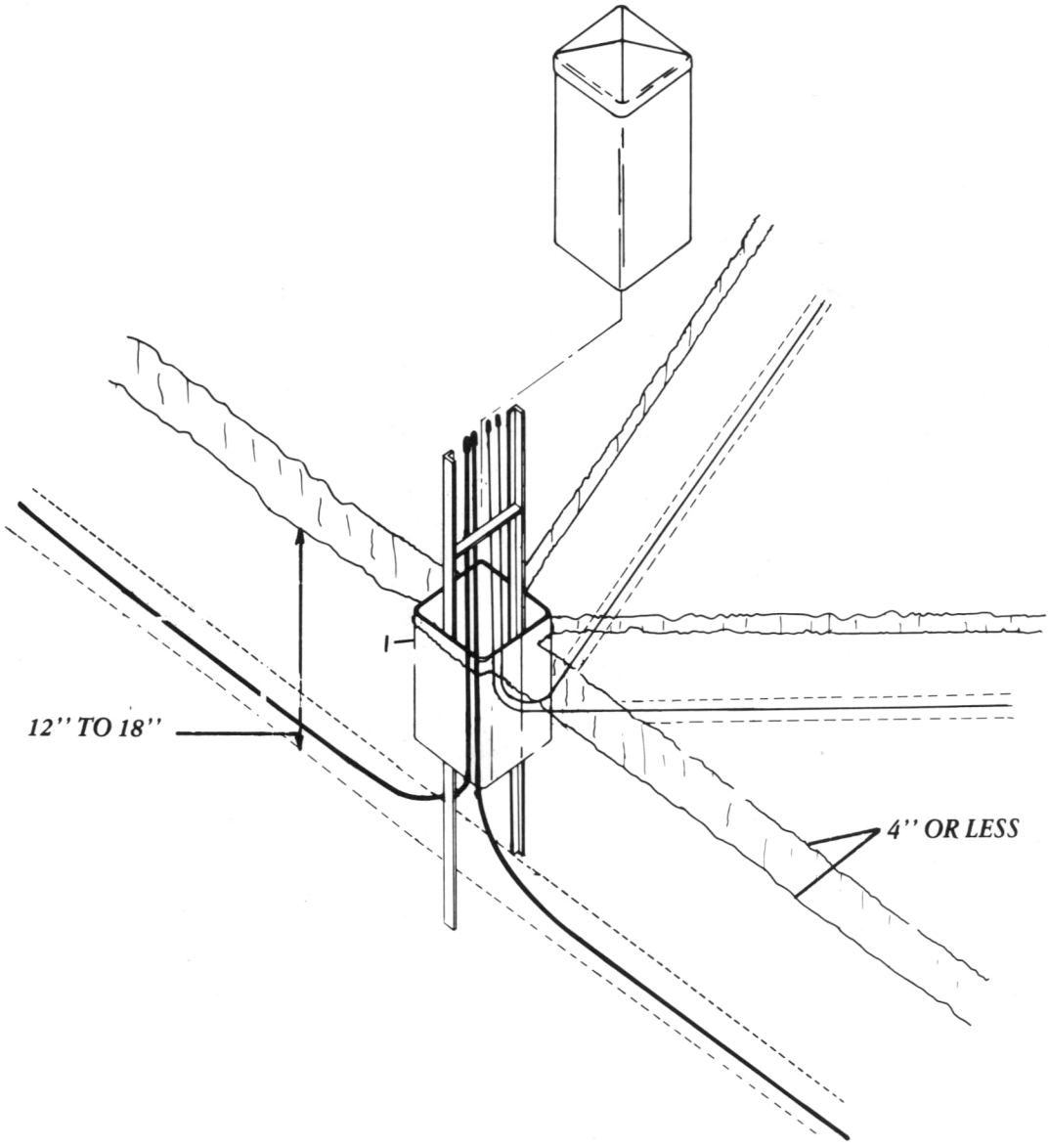
Page

FIGURE UG-1 AMPLIFIER PEDESTAL UG-93
FIGURE UG-2 PASSIVE OR TAP PEDESTAL UG-94
FIGURE UG-3 TAP PEDESTAL UG-95
FIGURE UG-4 VAULT UG-96
FIGURE UG-5 AMPLIFIER PEDESTAL/CONDUIT UG-97
FIGURE UG-6 VAULT WITH CONDUIT UG-98



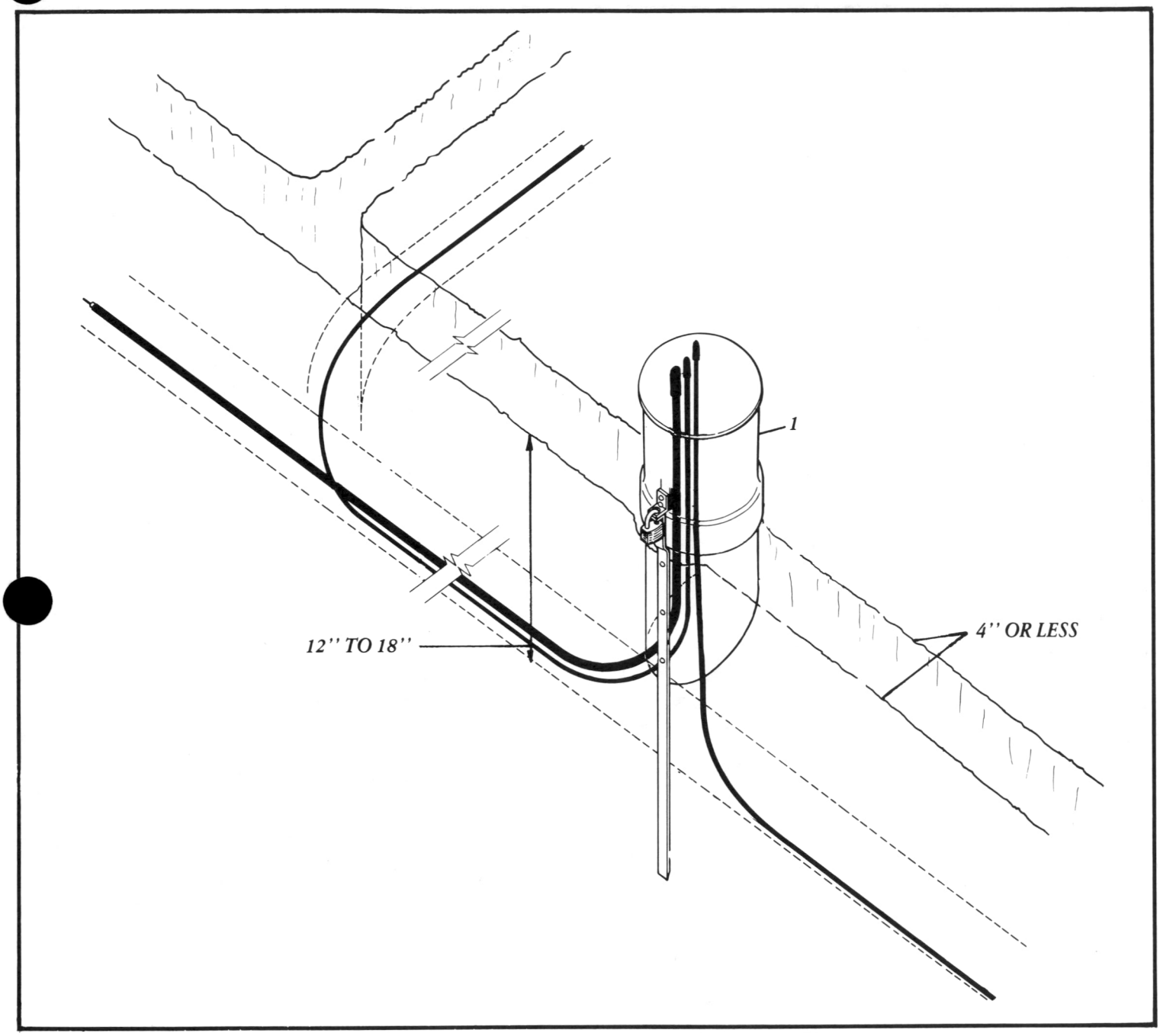
Item	*Description*
1	*Amplifier or Power Supply Pedestal*

FIGURE UG-1 AMPLIFIER PEDESTAL



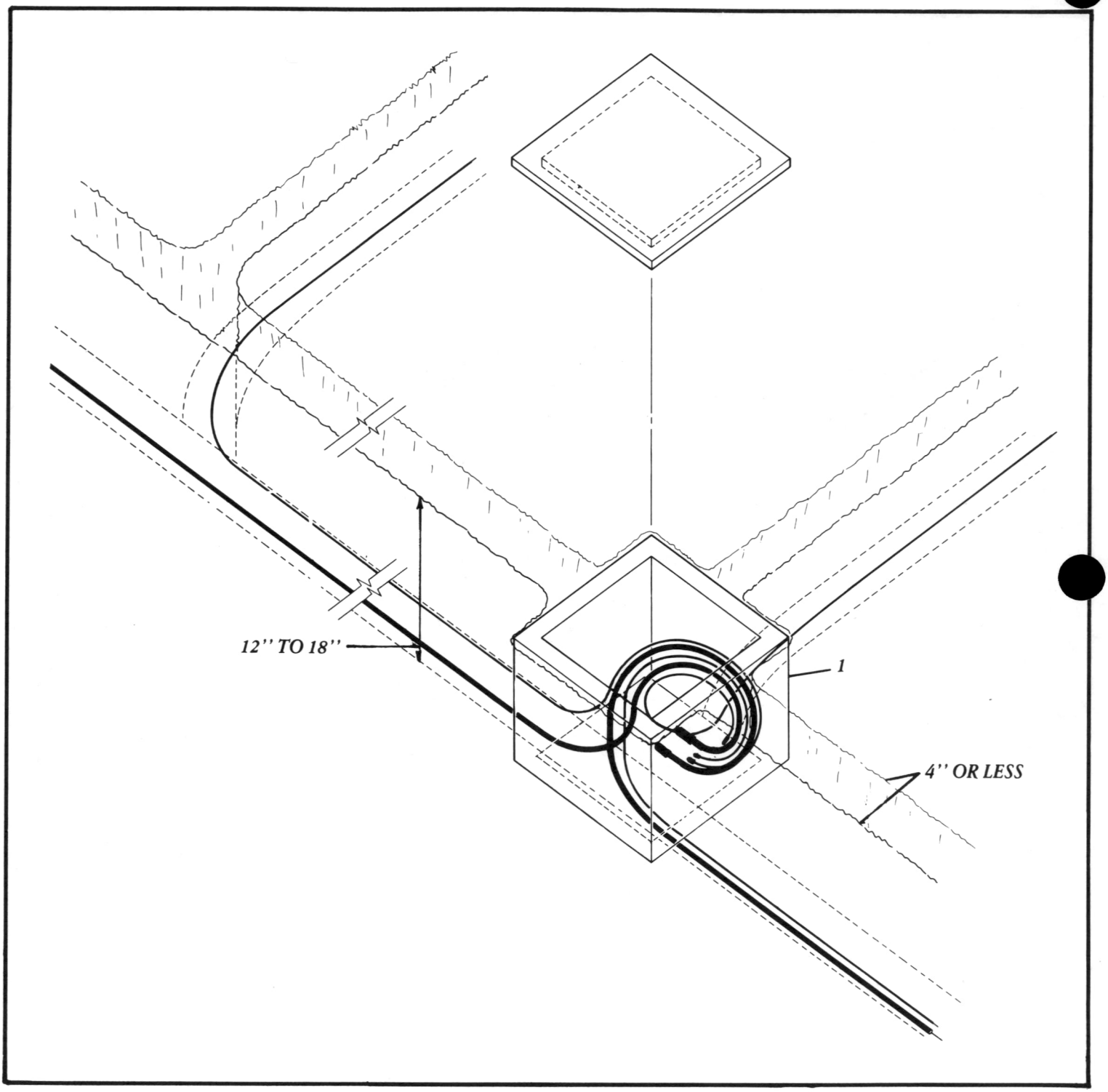
Item	Description
1	Passive or Tap Pedestal

FIGURE UG-2 PASSIVE OR TAP PEDESTAL



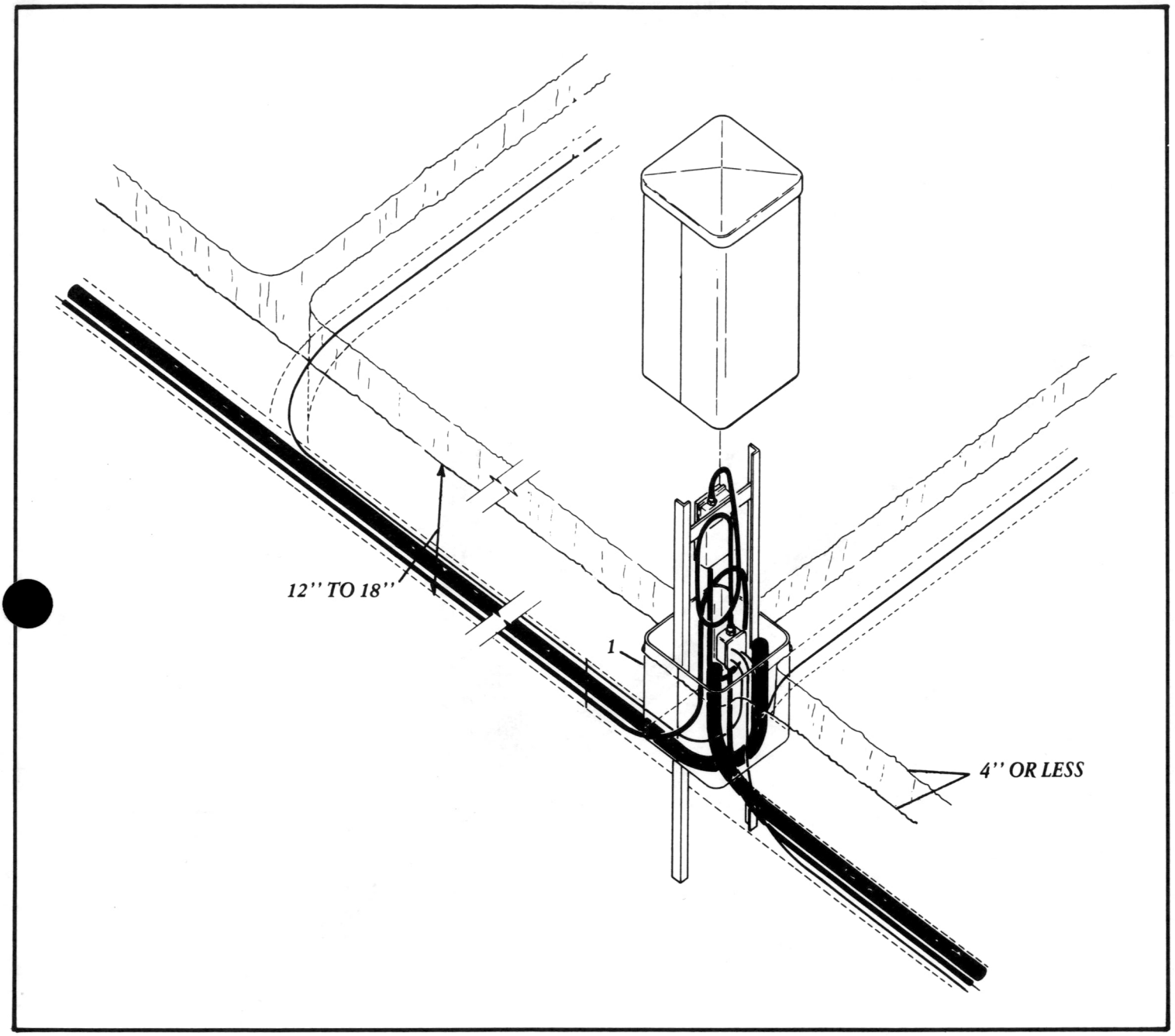
Item	*Description*
1	*Tap Pedestal*

FIGURE UG-3 TAP PEDESTAL



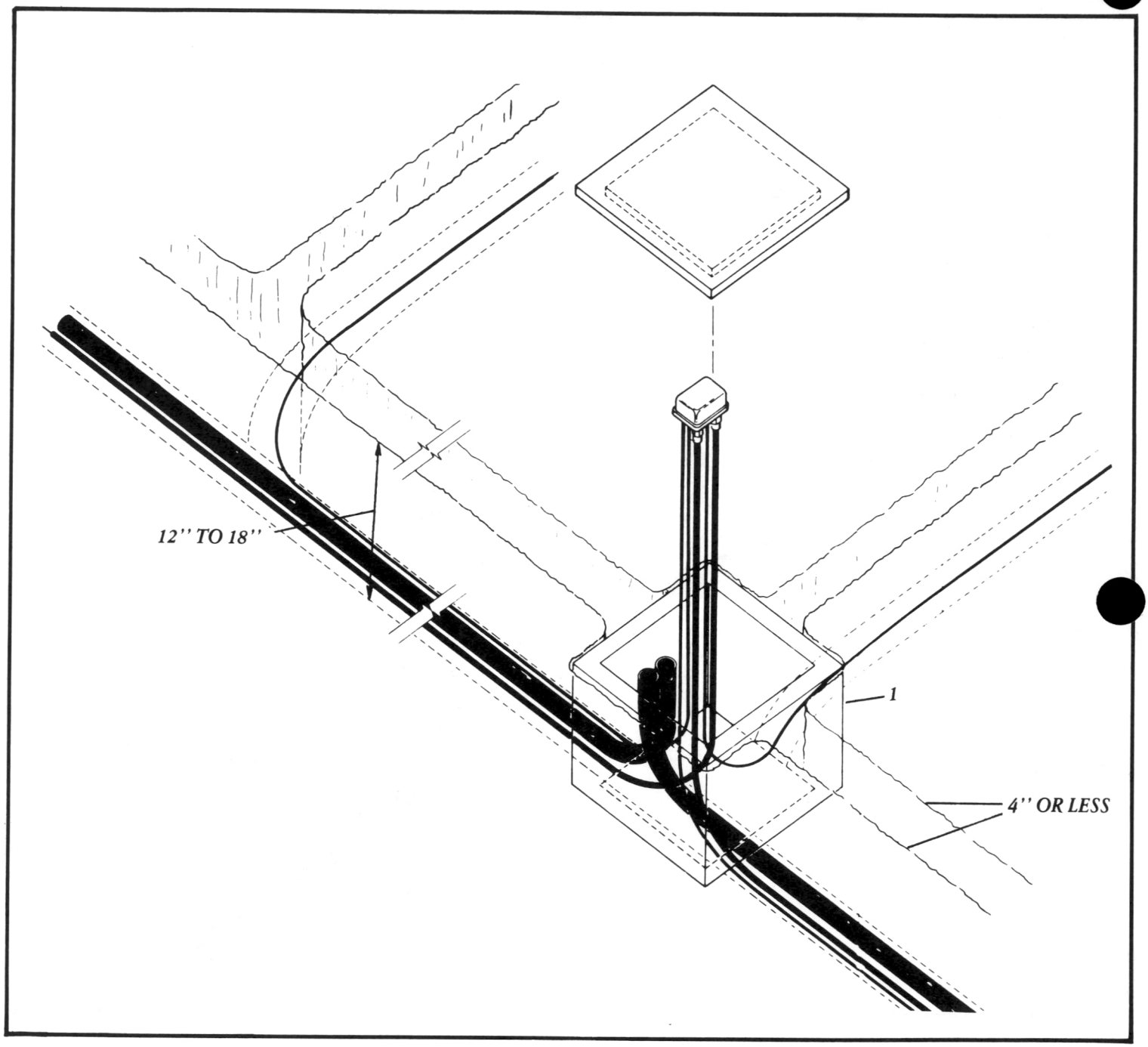
Item	*Description*
1	*Flush Mount Vault*

FIGURE UG-4 VAULT



Item	Description
1	Amplifier Splicing Pedestal-Conduit

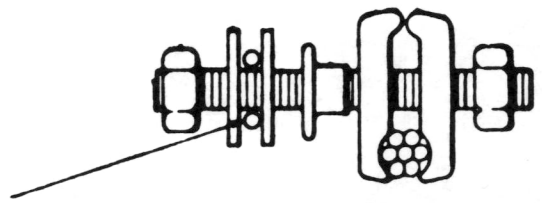
FIGURE UG-5 AMPLIFIER PEDESTAL/CONDUIT



Item	Description
1	Vault with Conduit

FIGURE UG-6 VAULT WITH CONDUIT

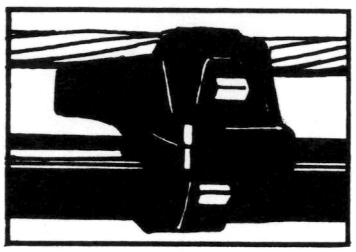
Special Installation Procedures Reference Data



Note: Lashing wire should go between the washers and no more than 1/2 wrap.

Note: The lashing wire shall be wrapped twice around the strand before terminating in the lashing wire clamps.

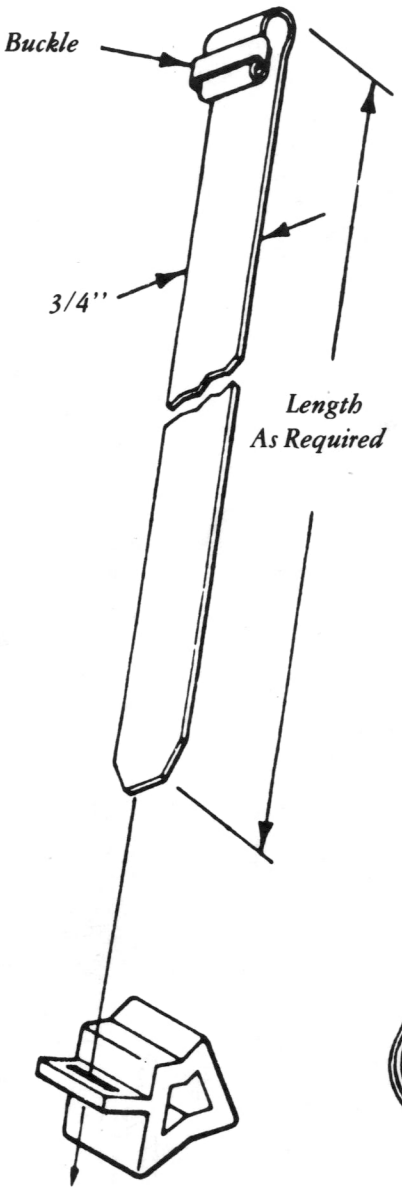
Aerial Cable Support and ½'' Cable Spacer

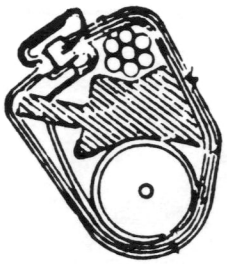


AERIAL SUPPORT TIE

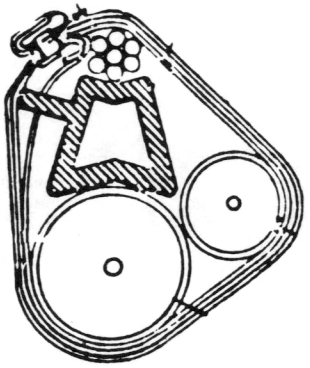
Cut and Tuck Lash Wire

FIGURE 1 CABLE PLACING - LASHING WIRE CLAMP - AERIAL SUPPORT AND SPACER

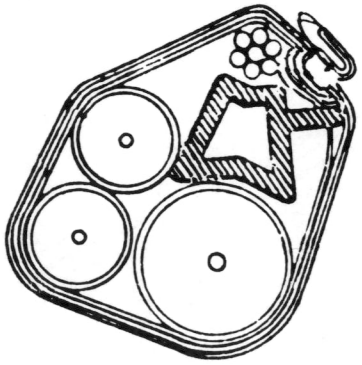




Single cable with spacer and aerial support



Dual cable with spacer and aerial support



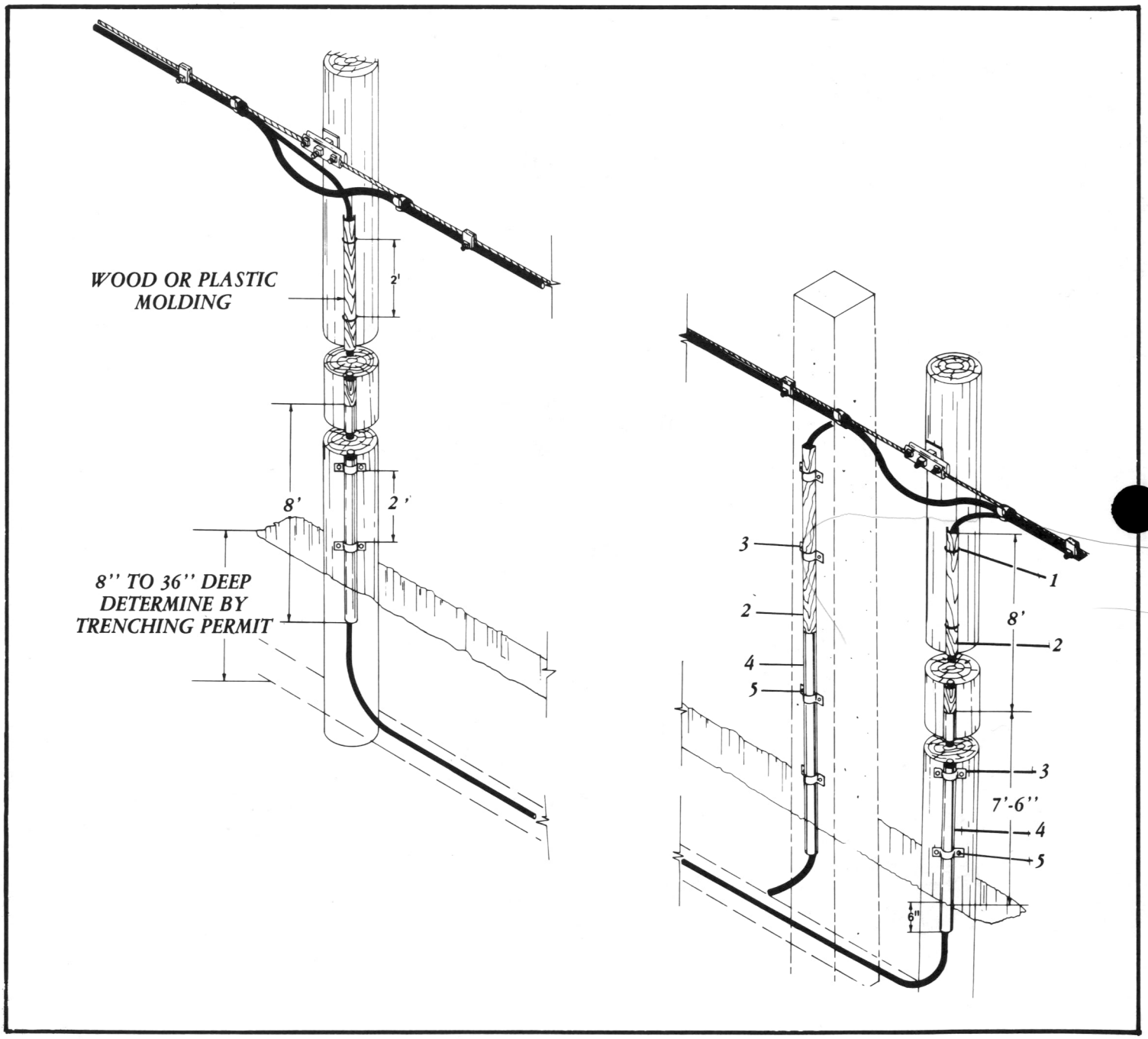
Triple cable with spacer and aerial support

Note: Wrap the aerial support around the strand and cable(s) 2 or 3 times. Pull each wrap tight, then fold the support under itself passing it through the buckle, then fold back over the buckle.

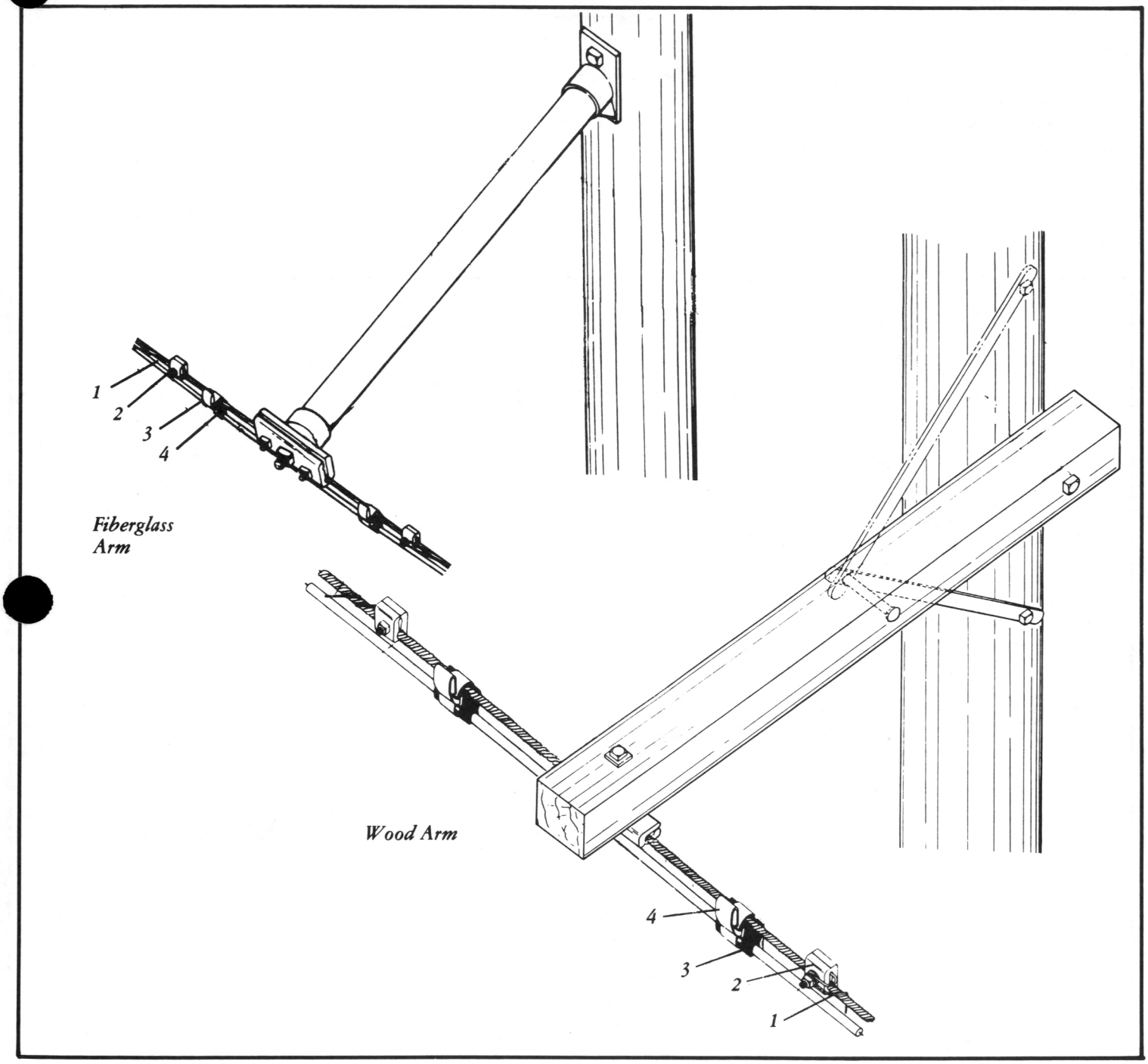
FIGURE 2 CABLE PLACING - AERIAL CABLE SUPPORT AND SPACER

INSTALLATION PROCEDURES - UNDERGROUND DIPS

At locations where it is necessary to place small portions of cable underground, the installation procedures shown in Figure 3 should be followed.



It is recommended that all underground cables be solid dielectric. Coppergard [R] or Aluminum foam dielectric with jacket and flooding compound. All splices made on underground dips are made on the poles at the strand level on each side of the dip, or in pedestals. The splices should not be buried.



	Fiberglass Arm		Wood Arm
1	0.045 Stainless Steel Lashing Wire	1	0.045 Stainless Steel Lashing Wire
2	Lashing Wire Clamp	2	Lashing Wire Clamp
3	Cable Spacer	3	Cable Spacer
4	Cable Support Strap	4	Cable Support Strap

FIGURE 4 CABLE PLACING - EXTENSION ARMS

EXPANSION LOOPS

In all cases, expansion loops should always be formed with a tool designed for the purpose and never by hand.

Expansion loops are formed at non-equipment locations with a fabricated expansion loop forming tool. (See Figure 5 and 6) At locations where amplifiers passive devices, power supplies and taps are installed, an expansion loop/bending radius tool is used.

FABRICATED LOOP FORMING TOOL

If locally fabricated forming tools are used, they should conform to the shape and dimensions as described in Figure 6.

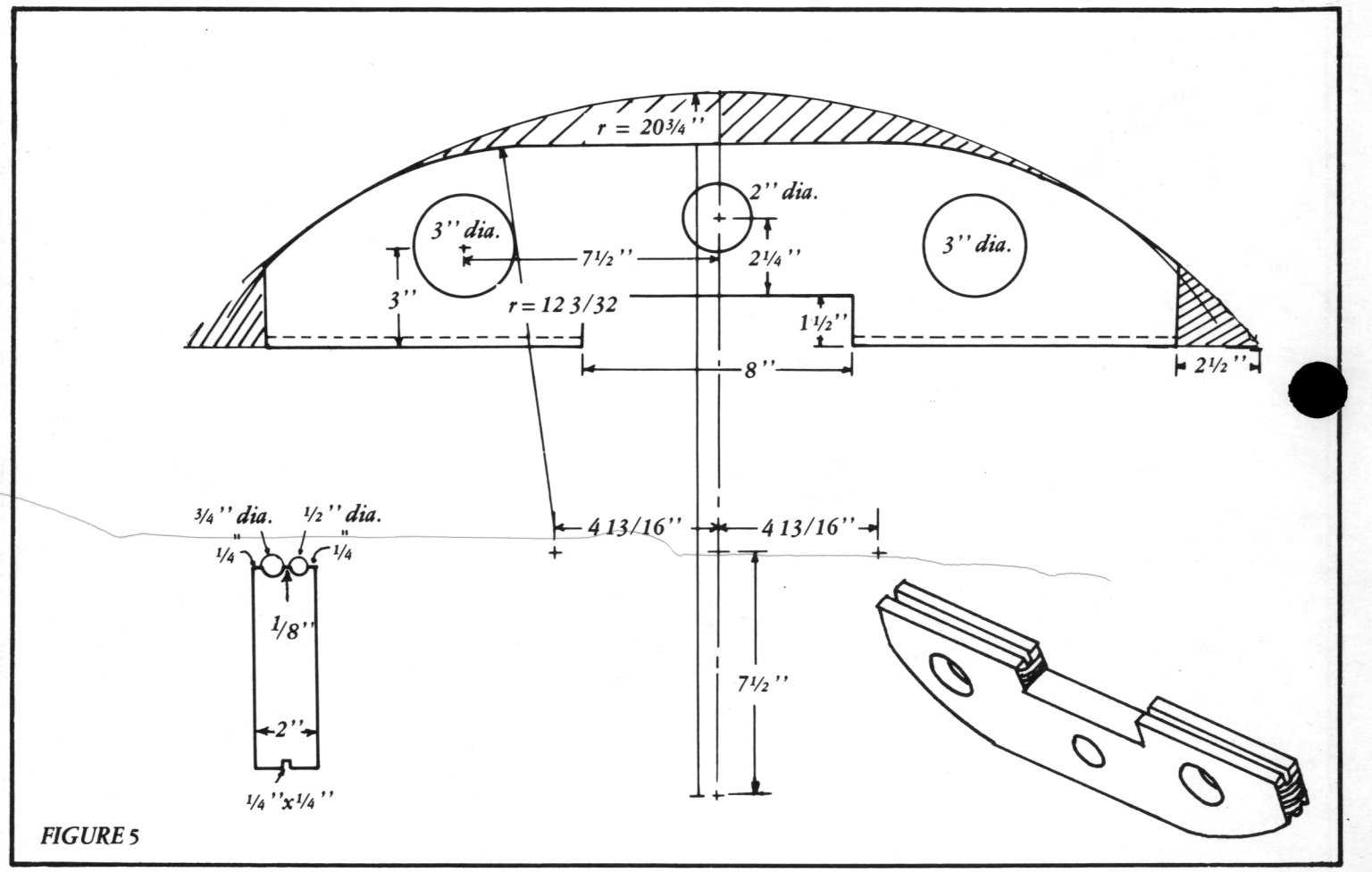


FIGURE 5

For 1.0'' inch cables mechanical expansion loop tools are recommended. See Figure 6.

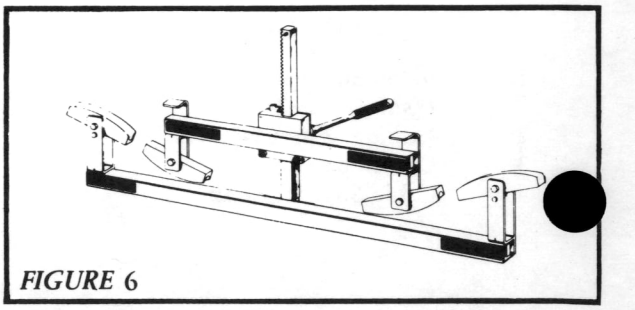


FIGURE 6

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